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FREE AIR

By Rufus T. Strohm

IT'S human nature, you can bet, to view as little more than trash the things for which we do not sweat or purchase with our hard-earned cash. The gifts we got last Christmastide — the knitted tie, the shaving cup — that led to thoughts of homicide, are now but playthings for the pup.

By contrast, note the lucky guy who through some shady dealings owns a dozen quarts of mellow rye that set him back a hundred bones. Does he go pouring it away as though it were as cheap as dirt? Nay most respected reader, nay; he doesn't, you can bet your shirt!

And yet a thousand boiler plants are run at low efficiency because the air supply, by chance, is inexhaustible and free. It doesn't come in tanks or cars; it brings no bills from any man; so firemen let down the bars and strive to use the most they can.

Now, every stoker is aware — if he has brains inside his poll — that less than twenty tons of air will fully burn a ton of coal; but since no Air Trust yet has tried monopolistic tactics here, his fire-holes, all yawning wide, admit great chunks of atmosphere.

If we could figure out a way to bottle up the seas of air, and make each boiler user pay a tidy sum to get a share, a lot of careless, wasteful guys, like Tom and Dick and Timothy, would soon be brought to realize a thing's not cheap because it's free.

Measurement of Surface-Condenser Leakage by Electrolytic-Conductivity Method

Difficulties in Applying Electrical Methods to Measuring Condenser Leakage—How Some of These Difficulties Have Been Overcome—How Measurements Are Made—Factors that Affect the Accuracy of the Measurements

BY EARL A. KEELER
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MEASUREMENT of condenser leakage by the application of electrical methods is by no means new. At various times during the last decade the advantages and possibilities of such methods have been pointed out. One of the most interesting and comprehensive papers on the subject is that of Digby, published in 1910.[1] The principle involved is invariably the same. Two electrodes are immersed in the water under test, and a measurement is made of the resistance offered to the flow of current between the two pieces of metal. The arrangement of electrodes, which is similar to the plates in a battery cell, is commonly called a conductivity cell.

APPLICATION OF CONDUCTIVITY METHODS

Until recently little progress had been made toward extensive application of the conductivity method to measurements of condenser leakage. The lack of suitable apparatus was largely responsible for this. The best equipment available required the use of high-frequency Wheatstone bridge and telephone receiver which, while extremely accurate, was found to be very troublesome to use under industrial conditions. For this reason the series-circuit method[2], utilizing a source of current and an ammeter connected in series with the conductivity cell, was more frequently used, as indicated in the schematic diagram, Fig. 1. One of the best-known forms of this equipment was constructed in a manner very similar to a "megger," with its scale calibrated in reciprocal ohms, which is a measure of the water's conductivity. The greatest disadvantage of such equipment arose from the inability to install the cells directly in the pipe line carrying the condensate and thus avoid taking samples of water before testing. Other modifications of the ammeter method possess disadvantages in that they are usually subject to line-voltage fluctuations and difficult to compensate for temperature changes. Then, too, such methods usually require the passage of comparatively heavy currents through the conductivity cell to secure sufficient sensitivity with the ammeter, so that electrolysis of the electrodes and polarization errors result.

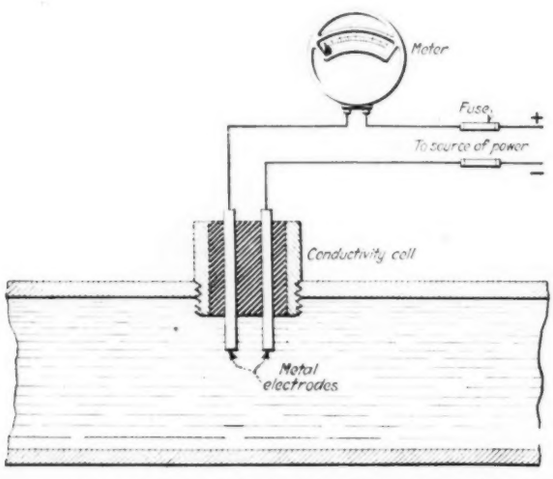

FIG. 1. SCHEMATIC DIAGRAM OF APPARATUS FOR MEASURING CONDENSER LEAKAGE

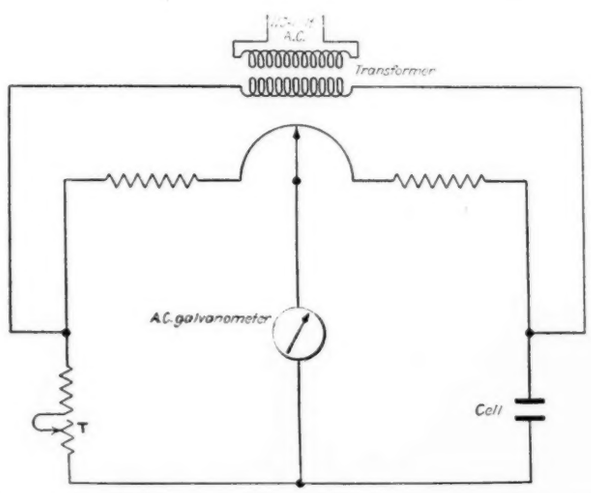

FIG. 2. SIMPLIFIED DIAGRAM OF CONNECTIONS FOR ALTERNATING-CURRENT WHEATSTONE BRIDGE

The recent development of a satisfactory alternating-current galvanometer has eliminated these difficulties and made possible the combination of high accuracy in measurement with rigidity of equipment. It is now possible to operate recording or portable equipment from commercial alternating-current circuits. Automatic signal lamps or bells can be utilized to indicate variations of concentration or leakage into the condensates.

ALTERNATING-CURRENT WHEATSTONE BRIDGE

Fig. 2 shows the simplified diagram of connections for the alternating-current Wheatstone bridge. The use of a transformer to separate the measuring circuits from the grounded commercial circuit is an important feature. Such an arrangement is independent of line voltage. The leads to the cells may be of practically any length. The current flow through the cell is extremely small and will not produce electrolysis of the cell elements or the piping into which it is installed. This fact, coupled with the advantage of small and compact construction, permits the use of a convenient and simple device for

[1] "The Examination of Water by Electrical Methods," by W. Pollard Digby. *The Electrician*, London, England, July 29, 1910.
[2] "The Electrical Method of Detecting Surface-Condenser Leakage," by W. E. Caldwell. *Power*, Aug. 9, 1921.

removal and examination of the cell without interrupting the flow in the pipe line. Fig. 3 shows an actual installation of a cell and cell-removal device in a pipe line, and Fig. 4 shows the cell and removal device in section. Fig. 5 is a reproduction of a record taken from an automatic recorder connected to a cell in a condensate line.

The important points to be considered before making an installation of conductivity equipment for condensate measurements are: (1) Quality of the cooling water: (2) calibration of the measuring apparatus; (3) variation in temperature of condensate.

Quality of Cooling Water Affects Accuracy

Quality of the cooling water has considerable bearing on the question of accuracy obtainable in condensate measurements. Fig. 6 shows two typical curves of resistance plotted against percentage leakage of cooling water into the condensate. Curve *A* was secured in a seaboard plant using cooling water approximately the make up of ocean brine. Curve *B* was secured in an inland plant using a cooling water that is probably fairly representative of conditions encountered in inland plants. It will be noted that for a 0.1 per cent leakage, which may be taken as representative of usual seaboard operating conditions, the resistance decreased about 80 per cent for the brine cooling water, or from 15,000 to about 3,000 ohms, while for the inland water the decrease is only about 17 per cent, or from 15,000 to about 12,500 ohms. Even if allowance is made for a permissible leakage of 1 per cent in inland-plant practice,

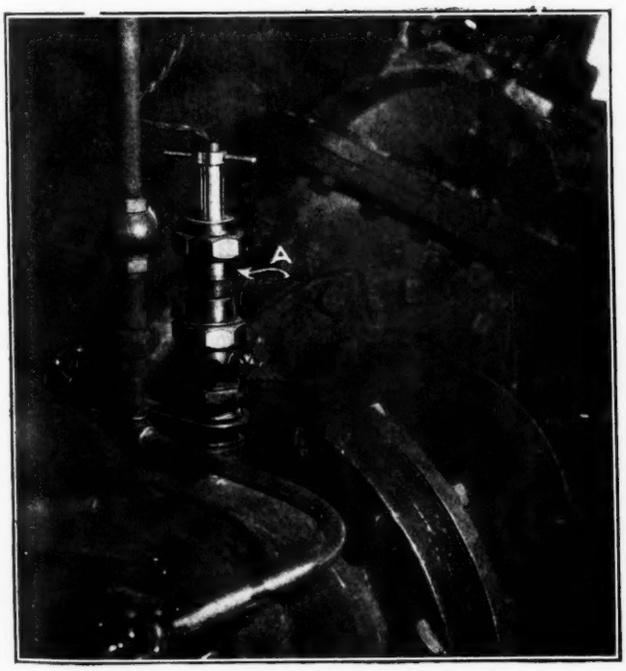

FIG. 3. INSTALLATION OF CONDUCTIVITY CELL AND REMOVAL DEVICE AT *A*

it will be observed that the drop in resistance is only about 50 per cent as compared with the 80 per cent secured for a leakage of 0.1 per cent under seaboard conditions. It is evident, therefore, that the sensitivity of a given instrument for condensate measurements decreases as the quality of the cooling water improves.

Low concentration of dissolved solids in cooling water does not always imply that greatly increased condenser leakage is permissible. Efficiency of operation depends upon the tightness of the condenser. Then, too, a cooling water containing a low content of dissolved solids quite frequently contains constituents or dissolved gases that must be kept out of the condensate. For these reasons the alternating-current galvanometer and Wheatstone-bridge method is preferable to the ammeter

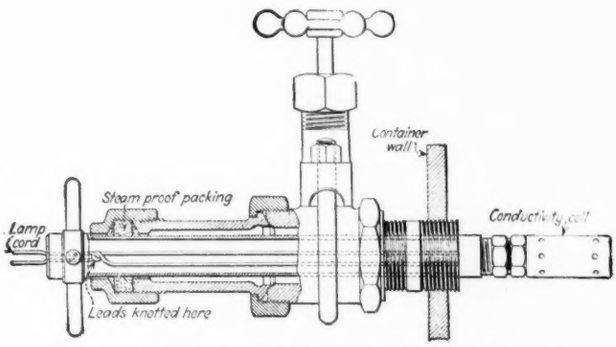

FIG. 4. SECTION THROUGH CONDUCTIVITY-CELL REMOVAL DEVICE

series-circuit-current methods for inland-water measurements. A good alternating-current-ammeter method will frequently meet practical needs for seaboard work, although for accurate measurements it is advisable to use the alternating-current Wheatstone-bridge method.

Apparatus for measuring condenser leakage may be calibrated in terms of (1) percentage leakage, (2) concentration of total dissolved solids, (3) chlorine content.

The question of calibration depends largely upon the purpose for which the measurements are to be used. If the purpose is to determine operating efficiency as in turbine water-rate tests, there is no doubt that the direct calibration in terms of percentage leakage is necessary. If, however, the main purpose in making the measurements is to aid in maintaining a pure boiler feed, it is better to calibrate apparatus in terms of concentration rather than in terms of percentage leakage. A measurement of percentage leakage requires constancy of quality of the cooling water and constancy of boiler priming. Variations of cooling water and boiler priming will produce apparent changes in percentage leakage, when the leakage is actually unchanged.

Changes in cooling-water quality occur frequently in plants using sea water diluted by river waters. The dilution of the sea water varies appreciably with the condition of the tides and the volume of river flow. For this reason it is usually advisable to calibrate the equipment in terms of total dissolved solids or chlorine content. Whenever sea water is the source of condenser leakage, it is customary to calibrate in terms of chlorine concentration. Since the ratio between the chlorine concentration and the other salts present is large and practically constant, such a calibration can be depended upon. In the case of sea water diluted with river water the extent of the variations will determine whether a chlorine or total solids calibration should be used.

To calibrate and use the equipment in terms of percentage leakage:

1. Secure a sample of cooling water and measure its resistance at some convenient temperature to be taken as a standard temperature.
2. Secure a liter of condensed steam, taking the

steam from a convenient source, near the turbine throttle, while running at normal load. Use care to avoid contamination during condensation. Measure the resistance of the condensed steam, using the temperature at which the cooling water was measured.

3. Add 1 c.c. of cooling water to the liter of condensed steam and again measure the resistance. This will give the resistance corresponding to 0.1 per cent leakage. Repeat, adding larger volumes of cooling water until sufficient data have been secured to plot a curve of resistance and percentage leakage.

4. Measure the resistance of condensates into which the leakage is to be determined using the standard temperature. From the resistance leakage curve the corresponding values of leakage percentage can be secured.

5. By repeating (1) and (2) checks on the constancy of cooling water and priming can be obtained.

Equipment Calibrated in Terms of Chlorine

To calibrate in terms of chlorine, measure the resistance of the conductivity cell immersed in condensate samples of various concentrations. It is best to make the measurements at an average operating temprature. The scale of the apparatus can then be calibrated in terms of the corresponding chemical determinations for these solutions. Care must be taken in measuring the solutions containing very low concentrations of dissolved salts since the conductivity will change with exposure to air. Corrections should also be made according to a "blank" titration made in distilled water.

The resistance of condensate decreases approximately 1.2 per cent for 1 deg. F. rise in temperature. For measurements not requiring high accuracy the apparatus may be calibrated at an average temperature to minimize errors. This is particularly true of seaboard

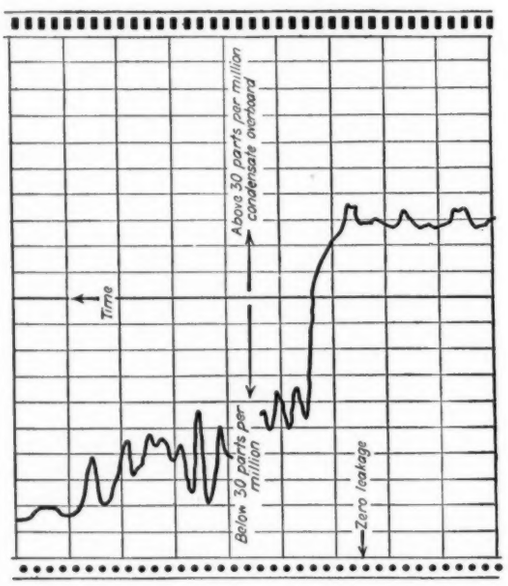

FIG. 5. RECORD OF CONDENSER LEAKAGE

or marine installations, since a resistance change of several per cent corresponds to only a small error in the leakage measurement.

For inland waters and seaboard measurements under conditions of large temperature fluctuations, it is advisable to utilize a compensation dial calibrated in condensate temperature. Fig. 2 shows the compensating resistance T controlled by this dial. The compensation is secured by occasionally setting this dial to a position corresponding to the operating temperature. For most work variations of 5 deg. F. or less can be neglected. In cases requiring extreme accuracy it is possible to compensate automatically for temperature changes.

It is worthy of note that the application of conductivity methods is not limited to measurements of condenser leakage. In many instances the determination of boiler-water concentrations and the control of the blowdown point are practical. The variations of boiler priming with load may be investigated by condensing the steam without leakage. The increasing use of evaporators to supply feed water is also providing other opportunities for the application of conductivity measurements to power-plant practice.

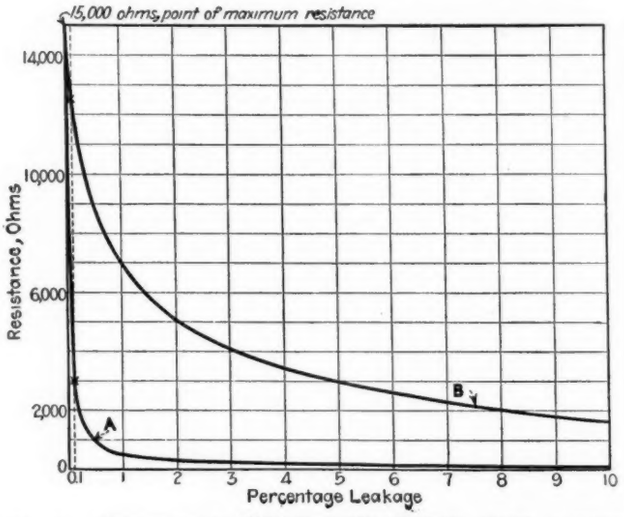

FIG. 6. RESISTANCE CURVES FOR CIRCULATING WATER

Specific Heat

The specific heat of any material is the number of B.t.u. required to raise the temperature of one pound one degree Fahrenheit. By the definition of a B.t.u. the specific heat of water is, of course, equal to 1. The specific heats of some well-known substances are approximately as follows: Aluminum, 0.21; copper (cast), 0.095; brass, 0.094; brickwork, 0.20; cast iron, 0.13; steel, 0.12; wrought iron, 0.12.

As an example of the use of these constants suppose that it is desired to find out how much heat will be absorbed by 1,000 lb. of wrought-iron piping at 70 deg. Fahrenheit, if steam at atmospheric pressure is admitted to it. On the admission of the steam the temperature of the pipe will rise approximately to 212 deg. Fahrenheit (the temperature of the steam). The temperature rise is 212 — 70 = 142 degrees. To raise one pound of wrought iron one degree, 0.12 B.t.u. is required. Therefore the heat required to raise 1,000 lb. through 142 degrees will be $1{,}000 \times 142 \times 0.12 =$ 17,040 B.t.u. About 17 lb. of steam would be condensed in heating up the pipe, assuming that a pound of steam gives up about 1,000 B.t.u. on condensing.

When a newly fitted brass is put into hard service, a little tallow in the clearances helps to prevent heating.

Wire Sizes for Motor Circuits

Size of Conductors for Motor Circuits as Required by the National Electrical Code

By EDGAR P. SLACK
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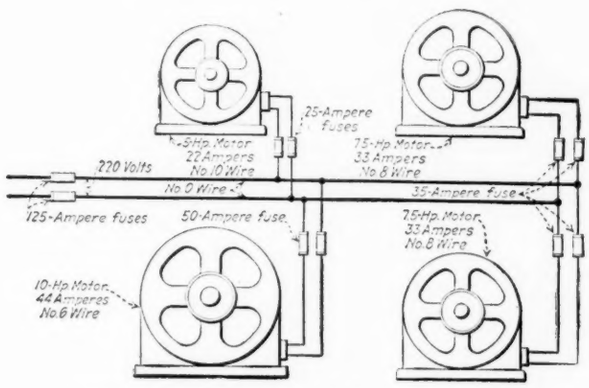
PROTECTION of motor circuits is of special importance because the wires are frequently concealed and inaccessible, thus making it difficult to locate and to extinguish a fire originating in the wiring. The National Electrical Code specifies certain allowable current-carrying capacities for wires and cables as given in the table, no wires smaller than No. 14 B. & S. gage being permitted for circuit wiring. The current flowing through a conductor produces a certain amount of heat, which in turn lowers the insulating value of the covering. For example, if the insulation resistance of a rubber-covered wire were 300 megohms (1 megohm = 1,000,000 ohms) per mile at 60 deg. F., it would be reduced to about 150 megohms per mile at 78 deg. F. Moreover, long continued heating of the rubber acts like over-vulcanization and deteriorates the quality of the compound, making it likely to break down in service. A No. 6 B. & S. gage rubber-covered wire is rated in Column A at 50 amperes, this current being such that the heating will be small and the insulation will have a reasonable life

Varnished-cloth insulation is not so much affected by heat and so has a higher rating, 60 amperes for No. 6 B. & S. gage, as indicated in column B. This insulation, being wound from narrow strips, does not resist the entrance of moisture as a homogeneous rubber covering does, and therefore may be used only in permanently dry locations. Also, the layers of insulation might be distorted if the wire were sharply bent, and so this type of covering is not allowed, except by special permission from the Fire Underwriters Inspection Department, for wires smaller than No. 6, when they are subject to severe bending. Other insulations, including weatherproof (useful for protection against corrosive vapors) and slow-burning (for hot, dry places) are still less affected by heat and have correspondingly higher ratings, as given in Column C, which gives 70 amperes as the allowable capacity for No. 6 B. & S. gage.

ALLOWABLE CARRYING CAPACITIES OF COPPER WIRES AS SPECIFIED BY THE NATIONAL BOARD OF FIRE UNDERWRITERS

B. & S. Gage	Diameter of Solid Wires in Mils	Area in Circular Mils	A Rubber Insulation Amperes	B Varnished Cloth Insulation Amperes	C Other Insulation Amperes,
18	40.3	1,624	3	....	5
16	50.8	2,583	6	....	10
14	64.1	4,107	15	18	20
12	80.8	6,530	20	25	25
10	101.9	10,380	25	30	30
8	128.5	16,510	35	40	50
6	162.0	26,250	50	60	70
5	181.9	33,100	55	65	80
4	204.3	41,740	70	85	90
3	229.4	52,630	80	95	100
2	257.6	66,370	90	110	125
1	289.3	83,690	100	120	150
0	325.0	105,500	125	150	200
00	364.8	133,100	150	180	225
000	409.6	167,800	175	210	275
		200,000	200	240	300
0000	460.0	211,600	225	270	325
		250,000	250	300	350
		300,000	275	330	400
		350,000	300	360	450
		400,000	325	390	500
		500,000	400	480	600
		600,000	450	540	680
		700,000	500	600	760
		800,000	550	660	840
		900,000	600	720	920
		1,000,000	650	780	1,000
		1,100,000	690	830	1,080
		1,200,000	730	880	1,150
		1,300,000	770	920	1,220
		1,400,000	810	970	1,290
		1,500,000	850	1,020	1,360
		1,600,000	890	1,070	1,430
		1,700,000	930	1,120	1,490
		1,800,000	970	1,160	1,550
		1,900,000	1,010	1,210	1,610
		2,000,000	1,050	1,260	1,670

The Code specifies that "conductors carrying the current of only one motor must have a carrying capacity of at least 110 per cent of the name-plate current rating of the motor." The current taken by a motor is not constant, as is practically the case with heaters, lamps and the like, but increases as load is applied to the machine; also heavy currents are generally taken at starting. The object of the foregoing rule is to provide an excess capacity so that the supply line will not be overheated by currents somewhat greater than normal. For example, a motor rated 58 amperes would require a line capable to carry at least 110 per cent of 58, or 63.8 amperes, and the smallest corresponding size of line permitted is found from the tables to be No. 4 B. & S. gage if the line is rubber-insulated; No. 5 B. & S. gage if varnish-cloth insulated; or No. 6 B. & S. gage if insulation of other types is used. There is no restriction against the use of larger wires than specified in this rule; in fact, larger wires are often needed. This question is discussed in a later article, in connection with the fusing of the conductors, these subjects being closely related.



FOUR MOTORS GROUPED ON ONE FEEDER

The foregoing rule deals with the capacity of conductors carrying the current of only one motor; that is, the final branch circuit supplying a single machine. Many installations consist of a group of motors, each motor on its own branch circuit, the branch circuits connecting to common mains; and a large installation generally has several such groups, with the mains supplied from a common feeder. The Code contains no rule covering the size of such mains and feeders directly, but it does specify that the rated capacity of fuses protecting them shall not exceed the carrying capacity of the conductors.

As an example, take the conditions shown in the figure. Here are four motors connected to the same feeder. Since the motors operate on 220 volts, they

will take about 4 amperes per horsepower. Then the 5-hp. machines will require $5 \times 4 = 20$ amperes under full load. To meet the requirements of the Code the wire will have to have 10 per cent more carrying capacity than the full-load current of the motor, and in this case $20 \times 1.10 = 22$ amperes. If rubber-covered wire is used, a No. 10 conductor will be required. For the two 7.5-hp motors the full-load current of each will be $7.5 \times 4 = 30$ amperes and the wire must have capacity for $30 \times 1.10 = 33$ amperes, or a No. 8 conductor. The full-load current of the 10-hp. motor will be $10 \times 4 = 40$ amperes, and the wire size will be for $40 \times 1.10 = 44$ amperes, or a No. 6. The total full-load current of all the motors is $20 + 30 + 30 + 40 = 120$ amperes, which is the capacity the feeder must have if all the motors are to be operated under full load at the same time. This would require a No. 0 wire and it may be fused to 125 amperes. If the total motor load did not at any time exceed 70 per cent of this total full-load capacity or $120 \times 0.70 = 84$ amperes, then a No. 2 conductor can be used for the feeder and fuse to 90 amperes. However, if a condition did arise where all the motors were carrying full load, the 90-ampere fuses would blow.

To be on the safe side each main and feeder would have a capacity equal to the combined capacities of all the wires branching from it, under which conditions all the motors could be run at the same time without overheating any supply conductor. In special cases where it is impossible to operate all the machines simultaneously, the mains and feeders may be smaller than the combined capacity of the connected circuits, provided the sizes of the fuses protecting them are correspondingly reduced. Blowing of these fuses under normal conditions would indicate that mains or feeders too small for the job had been installed, and it would then be necessary to go to the expense of running another circuit. For this reason if the feeders are installed with less capacity than the combined full-load ratings of the motors, load conditions should be given very careful study before installation, to make sure that the main and feeder fuses will not blow under service conditions.

Height of Boilers Above Floor*

By F. W. Dean

There is a mistaken policy at present, of mysterious origin, of, in general, placing boilers very high. This is done for the purpose of obtaining room for combustion on the assumption that great room is necessary. It is overlooked that horizontal space, when such is available for gas travel, is as good as vertical, and the only boilers that lack in the former are water-tube boilers with transverse baffles. The only way to obtain combustion space in these boilers is to place them high, and I am inclined to think that they are responsible for the mania.

With other types, such as the horizontal return-tubular and horizontal water-tube boilers, the space is abundant for the best results, even with low settings. This is apparent when it is considered that the best combustion can be obtained in the furnaces of Scotch marine boilers in which there is almost no vertical space and no great horizontal space, with the added assumed disadvantage that the fire and evolved gases are surrounded at close quarters with steel plates in contact with water.

If air can be admitted where it will penetrate the combustible gas, the combustion will occur instantly. The narrower this space the more perfectly the necessary mixing will occur. For this reason it is apparent that the greater the elevation of boilers with horizontal gas travels, the more uncertain the gas and air mixture becomes, and the more the boilers are elevated the less efficient the boilers are. It should not be forgotten that horizontal return-tubular boilers, when set low, have low combustion space only at the center.

The elevation of the boilers with transverse baffles only to a slight extent improves the mixture, as currents are almost vertical and parallel and have but little opportunity to mix and burn. Elevating such boilers is only groping in the dark, and with most other types elevation is harmful. When, in connection with this, the extra cost of the brickwork and the greater opportunity for cracks, which admit air that does not support combustion and cools off the boiler, are considered, the harm of high settings is evident.

The best place to admit air to hand-fired boilers, especially with horizontal gas travel, is at the bridge wall, for the air then has the best opportunity to penetrate the combustible gases. There are devices on the market for doing this.

In the case of mechanical stokers the foregoing remarks concerning space apply, but with pulverized coal more space is required because the fuel moves, but here again horizontal space is as effective as vertical.

Height of Bridge Walls

The height of bridge walls appears to be a matter of great uncertainty, as they are sometimes made low and sometimes high.

The main purpose of a bridge wall is to limit the fuel bed and to prevent the coal from being thrown over it. Many bridge walls in marine boilers are only 9 in. high, because the furnaces are small. They answer the purpose, and it is safe to say that no bridge wall need be over 12 in. high, or 15 in. at most. The bridge wall, as far as its height is concerned, does not assist in burning carbon to CO_2, which is the great object in view, and other considerations must therefore determine its height. A high bridge wall might project a great quantity of hot gas on a part of the boiler within which dirt has lodged, and thus cause overheating and injury.

There is no doubt whatever that if the combustion is complete, the heat will be absorbed without being directed against a small part of the shell. If boilers are set very high, a high bridge wall may cause air to reach combustible gases that it would otherwise be unable to encounter, but I can see no other advantage.

*From a paper before the New England Water Works Association.

Tungsten has a positive temperature coefficient—that is, the electrical resistance increases with the temperature—consequently the cold resistance of the filament of this class of lamps is much lower than when hot. This characteristic results in a heavy inrush of current through the lamp when first connected to the line, which gradually decreases to the normal current of the lamp as the temperature of the filament increases. At the instant of closing the switch this inrush may amount to six times the normal current of the lamp, but in 0.02 of a second has decreased to practically normal value.

Mechanical Trash-Rack Rake

By I. W. JONES

IT IS a well-known fact among users of water power that the removal of leaves, sticks and other débris that accumulate on the trash racks is a serious and expensive problem. This is particularly true in the case of large modern hydro-electric plants, where of necessity the trash racks are of great depth. In fact, it is practically impossible to effectively remove the débris to any great depth by the process of hand raking.

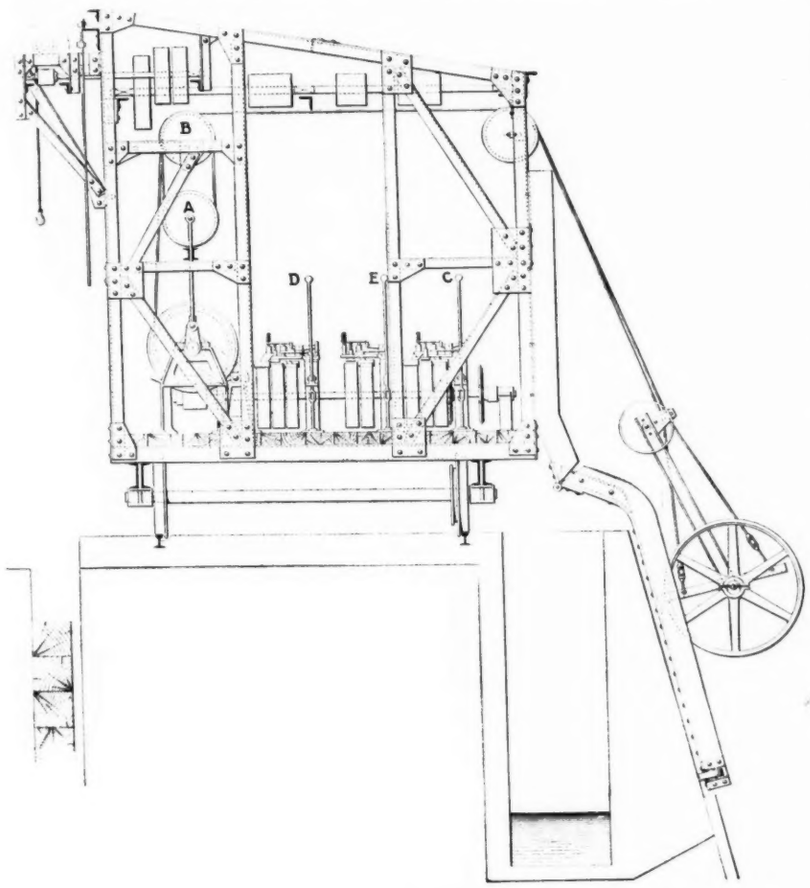


FIG. 1. ELEVATION OF RACK AND RAKE, THE LATTER BEING IN ITS OPERATING POSITION

The result is that the racks are seldom completely cleared, and consequently, there is more or less loss of head which, in turn, results in loss of production. This condition is often a serious one, involving the employment of a large number of men in an attempt to keep the racks clear, particularly at the time when the stream carries a large quantity of leaves.

Realizing the need of some mechanical device that would speedily and efficiently clear the racks and obviate the necessity of employing a large number of men by the hand-raking method, the writer developed a mechanical rack rake that has proved in actual operation to be practical and efficient.

The machine consists of a motor-operated car mounted on wheels designed to travel on rails inlaid in the rack platform. Hinged on the side of the car is a plate-steel apron extending downward and just clearing the tops of the rack bars. Near the bottom and at either side of the apron are placed wheels which travel on the concrete face of the forebay wall.

The rake is supported by a light structural-steel framework and operated by four steel cables running over sheaves attached to the car and thence to operating drums. The rake itself is composed of light steel angles, the raking ends of which are cut at an angle and so spaced that the points ply between the rack bars. Underneath and extending across the width of the rake and riveted to the angles forming the teeth is a steel angle which serves to strengthen the rake and at the same time forms a stop to prevent the teeth from coming in contact with the rack-bar separators. Extending transversely across the rake is a shaft with suitable bearings attached to the rake and on which it swivels. This shaft forms an axle at either side of the rake for large guide wheels that guide it in its downward travel, which is then in a vertical position, thus preventing the rake rigging from coming in contact with the accumulated débris on the trash racks.

The rake is provided at the back with a steel-plate fender which prevents the accumulated material from falling off when advancing to the dumping position. On the face of the large guide wheels are flanges designed to keep the rake in alignment in its downward travel. Two smaller guide wheels at the top of the structural-steel framework serve to keep the rake in alignment in its upward travel as it approaches the dumping position.

Fig. 1 illustrates the car in transverse section, also the rake in the operating position and the operating mechanism in elevation. As will be observed from Figs. 2 and 3, the framework of the car is composed of structural steel with a covering of corrugated iron. Windows in the side of the car permit the operator to observe the movements of the rake, and at the same time he is sheltered from the weather.

On substantial stands resting on the floor of the car is mounted the mainshaft, on which are suitable tight and loose pulleys, belt-driven from a countershaft in the top of the car. On the extreme left-hand end of the mainshaft is a worm pinion which actuates a worm-wheel on a hollow drum shaft, and within this hollow shaft, also worm-driven, is a solid shaft to each end of which is attached a crank. These cranks, when reversed in position by one-half revolution, separate the sheaves *A* and *B*, Fig. 1, by shortening the cables attached to the near side of the rake, and move the rake from a vertical to a horizontal, or working, posi-

tion. By completing a full revolution of the crankshaft, the rake is again brought into dumping position.

The movement of the car forward and backward is actuated by means of worm gearing and a sprocket chain drive controlled through the lever *C*. When this lever stands in a vertical position, the car is at rest; when pushed away from the operator, the car moves in that direction; and when moved toward the operator, the movement of the car is reversed. These results are obtained by the use of tight and loose pulleys and proper shipping forks which, in connection with the lever, govern the location of the driving belt.

The movement of the rake, both up and down, is controlled by the lever *D*, and when this lever is in a vertical position, the cable drums are still. When the lever is moved away from the operator the rake assumes an upward motion, and when the lever is reversed a downward motion is given to the rake. An automatic stop motion is also provided with this branch of mechanism, so that when the rake reaches its prearranged extreme downward location, the driving belt is automatically shipped to the loose pulley and an automatic

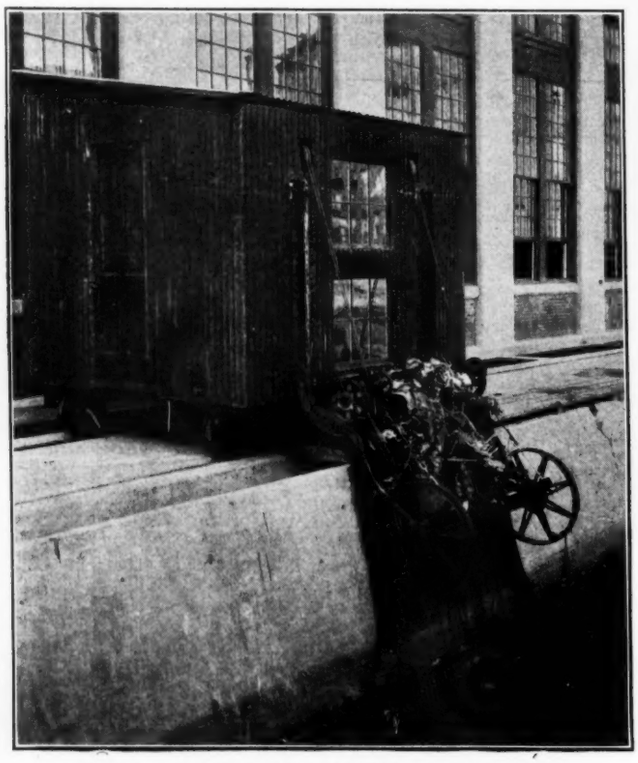


FIG. 2. RACK RAKE LOADED WITH REFUSE

brake is instantly applied. Again, when the rake reaches its extreme upward, or dumping, position the belt is automatically shipped, so that through the carelessness or inattention of the operator the cables cannot unwind too far when the rake is at its extreme bottom position or wind up too far when it is in its dumping position.

Lever *E* actuates the crankshaft and through its connections lengthens or shortens the nearer cables, as previously described. The countershaft is driven by a small motor in the top of the car. Current is provided for driving the motor through a long flexible cable attached to plugs located at intervals in the station walls. This may be substituted by an overhead trolley wire if desired.

The rigging shown outside of the car and near the top at the left in Fig. 1 was especially designed for removing stop-out timbers and has no connection with the rack-raking operation.

Figs. 2 and 3 show the machine complete as installed in the new hydro-electric power station of the Lockwood Co., at Waterville, Me., for which place it was originally designed. Fig. 2 illustrates the rake loaded and advancing toward the dumping position, and Fig. 3 shows the rake after dumping and in position for its downward travel.

In this case a sluiceway, extending the full length of the rack, was constructed in the forebay wall, as shown

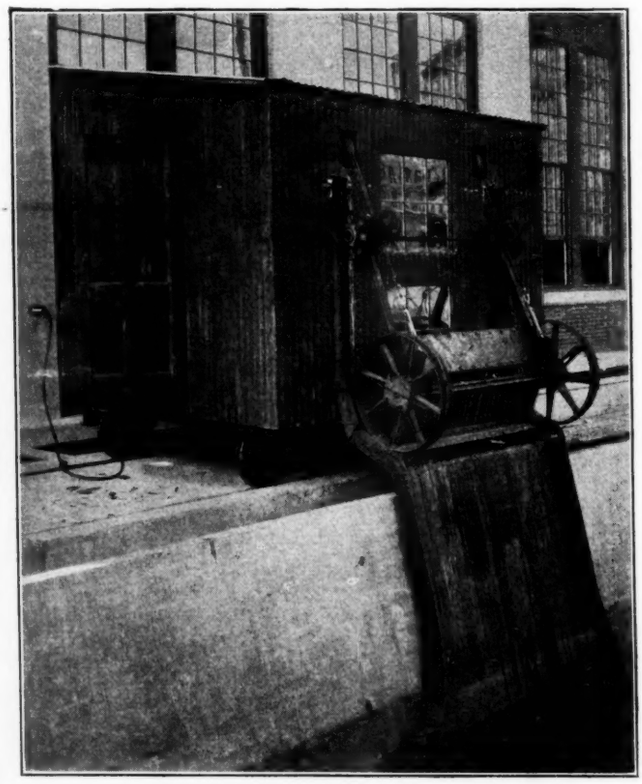


FIG. 3. RACK RAKE IN DUMPING POSITION

in section in Fig. 1. At one end a gate is provided by which water is let in, and at the opposite end is an opening through the side wall of the forebay, so that the refuse dumped from the rake is carried off automatically by a current of water from the forebay.

This machine is operated with but one man, who, with the power from a small motor, can quickly and efficiently keep the racks free from débris, as against the employment of a number of men who cannot possibly do the work efficiently by hand raking.

Specific resistance of brushes for electrical machinery —that is, the resistance in ohms per inch cube—is usually listed by brush manufacturers for all grades. This characteristic, however, need not be given much consideration in the selection of brushes. Its most important influence is on the carrying capacity of the brush, and that figure being influenced by the heat-conducting properties of the brush material, its friction and numerous other factors, the manufacturers rating for carrying capacity should be the determining factor rather than the specific resistance.

Remodeled Naval Proving Grounds Power Plant

By P. J. SEARLES

Besides describing the changes that were made, total cost figures are given for the new boiler, stoker, generator, electrical and auxiliary equipment, etc. The plant was kept in operation while the work of remodeling was going on. How the difficulty arising in supporting the steam pipes was overcome is illustrated and explained.

THERE has recently been completed at the Naval Proving Ground, Indian Head, Md., a considerable remodeling of an old power plant to provide increased power facilities for an enlarged smokeless-powder factory. The original plant was built a number of years ago and was extended to some extent in 1916, but when the powder factory was considerably enlarged it was found that an increase in power was required. A new power plant was considered, but comparative estimates showed that the old plant could be enlarged to meet new conditions with much less expenditure and probably equally satisfactory results.

Fig. 1 shows in full lines the outline of the original plant and in dotted lines the building extensions with new equipment and locations of old units. The old plant was a brick structure of three parts—boiler, engine, and compressor rooms. In the boiler room were six 6,000-sq.ft., four 3,530-sq.ft., and two 2,620-sq.ft. water-tube boilers, served by underfeed stokers fed from an overhead concrete coal bunker taking coal from an outside storage pile by the use of conveyors. The 6,000-sq.ft. boilers were on the west side of the room with a 200-ft. radial-brick stack outside, and the other boilers were on the east side with three 110-ft. steel stacks. Alongside the latter boilers at the north end were two pumps, driven by steam turbines, two feed-water heaters and three forced-draft fans. In the engine room were two 455-kw., one 1,500-kw. and one 3,000-kw. turbo-alternators with necessary exciters; two rotary converters for supplying direct current to the station trolley system, switchboards, etc. In the compressor room was one old steam-driven compressor of 1,300 cu.ft. capacity, and a motor-driven compressor of 1,500 cu.ft. capacity.

The general changes consisted of removing the six boilers on the east side of the boiler room for use at another station and replacing them by four 10,000-sq.ft. water-tube boilers, enlarging the boiler room, replacing the three steel stacks (which were used at another station), by a 250-ft. radial-brick chimney, relocating the fans, heaters and pumps, adding two new heaters, one pump and one fan, building a new compressor room, installing two new synchronous-motor-driven compressors, installing a 7,500-kva. turbo-alternator with exciter, switchboard, condensers, pumps, etc. While the work was going on, it was essential to keep the plant in operation, and this, of course, added to the complexity of the job. An attempt was made to keep several items of work under way concurrently so as to secure speed, and in a way to avoid interference with operation.

The first item of work undertaken was replacing six small boilers. It was necessary to tear down the east

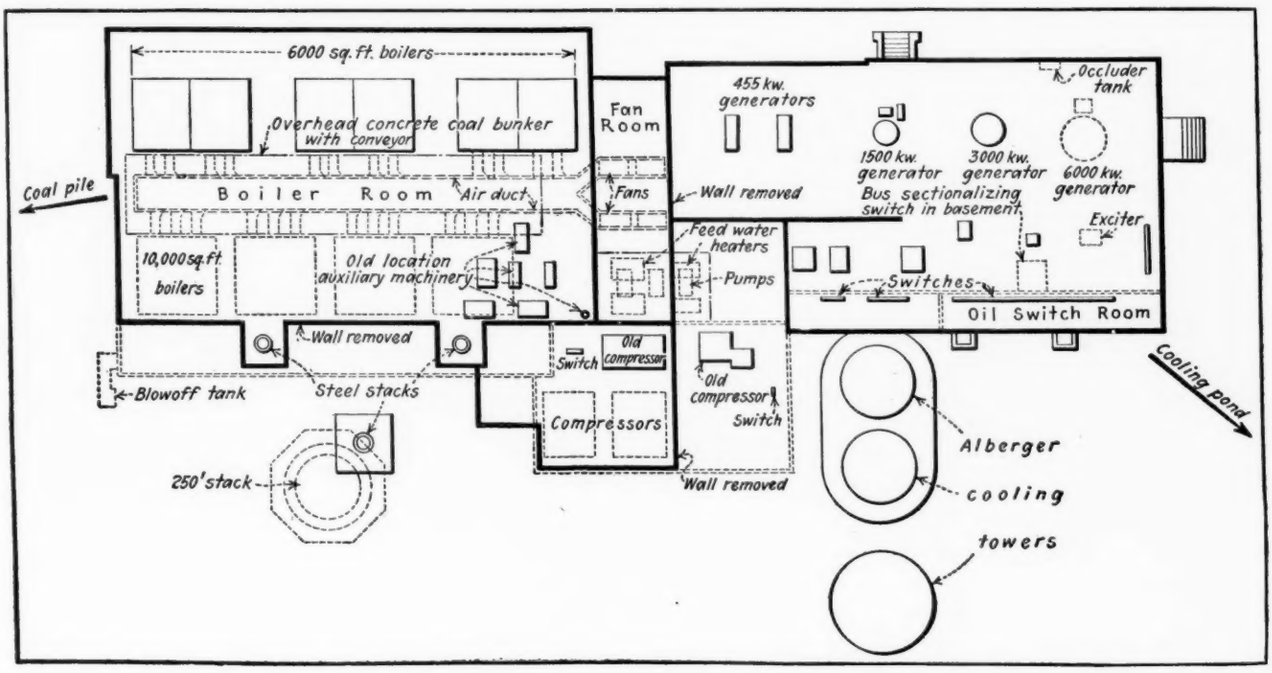


FIG. 1. PLAN OF OLD AND NEW LAYOUT OF THE REMODELED PLANT

wall of the boiler room and erect a new wall of concrete and steel sash about 20 ft. farther out. The old boilers were removed with care and were shipped to the Naval Station at Dahlgren, Va., where they are now in use. The old foundations were blasted out to make way for the new, approximately 1,000 cu.yd. of reinforced concrete and 1,000 cu.yd. of hard clay being removed. The new foundations of reinforced concrete four feet thick were built in four connected sections. Piers and side and end walls were placed, suitably pierced for air ducts, and with an ash tunnel 6 ft. high by 5 ft. wide at the rear.

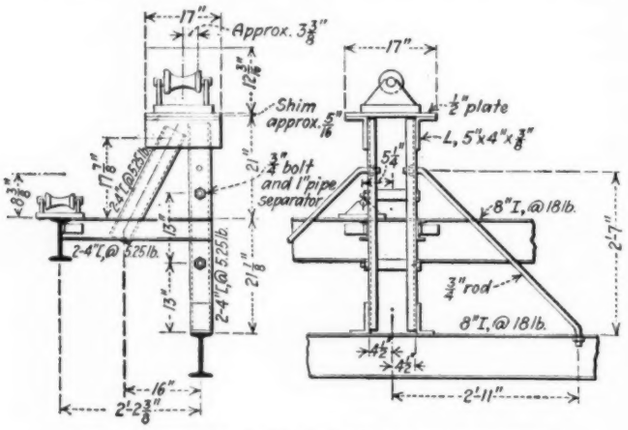


FIG. 2. DETAILS OF STEAM MAIN SUPPORTS

In the ash tunnel is an industrial track for the removal of ashes to a whip, hoisting them to an overhead bunker at the south end of the building, whence they are chuted into gondolas for disposal. On the foundations were erected four 10,000-sq.ft. boilers at a cost of $158,000, each being stoker fed.

The main steam header is of 10-in. extra-heavy steel pipe and supplies steam to various turbines, with take-offs to stokers, fans, pumps, etc. Steam is also supplied through 6- and 8-in. lines to various industrial buildings in the powder plant. Exhaust steam is used for heating the feed water and is also used in heating several near-by buildings. The heaters receive their water supply from various condensers through an 8-in. condensate line with makeup connection to the station water-supply system.

The main steam line forms a loop around the boiler and engine rooms, so valved that any one or all boilers may be cut in or out of service. Ample expansion joints are provided, including a U-bend of 11-ft. diameter. A difficulty arose in supporting the steam main and the 6-in. feed-water line. It was intended to hang these from roof trusses, but upon investigation it was found that the latter would not stand the extra stress. Several ideas were worked up, but finally 8-in. channel columns were placed alongside the boiler buckstays with 6-in. I-beams running between these above the boilers. On the beams were riveted roller chairs which support the mains. Details are shown in Fig. 2.

To provide room for the new boilers, it was necessary to relocate the auxiliary machinery. A steel platform 12 ft. high and 575 sq.ft. surface, was built in the fan room (part of the old compressor room), and on this were placed the two old heaters of 60,000 lb. water capacity, and two new heaters of 90,000 lb. water capacity. Directly beneath are two old and one new pumps, each of 600 gal. per min. capacity. In the same room are the old fans and a new fan of a total capacity of 130,000 cu.ft. free air under a static head of 3 in. of water. The fans all discharge into a central concrete duct running the length of the boiler room with offtakes to all boilers, including special connections to the non-clinkering type grate blocks.

The compressor room was built of brick, concrete, and steel sash with precast gypsum slab roof. Two synchronous-motor-driven compressors of a total capacity of 5,200 cu.ft. of free air per minute were installed with switchboards, water supply, air intakes, etc.

The engine room was remodeled to provide space for a 7,500-kva. turbo-alternator, with space also for a future unit. The new alternator is the largest installed in any navy yard. It is provided with condensing equipment to care for 20 per cent overload with a safe margin for temperature conditions of the circulating water. The cooling towers did not have sufficient capacity for the new alternator, so it was necessary to construct a cooling pond two hundred feet away. The cooling pond is of concrete 184 x 104 x 5 ft. and is connected with the condensers by a 24-in. suction and a 30-in. discharge cast-iron pipe. Makeup water is taken from the station's water supply (600-ft. artesian wells), which is free from carbonates and sulphates and is excellent for boiler feed.

An interesting part of the alternator equipment is the occluder and occluder tank. This device, which is practically the reverse of an injector, is used to increase the turbine vacuum, is alongside the turbine and discharges occluded air and steam through a 6-in. steel pipe into a tank (with water drain and air relief) 32 ft. above on a steel support.

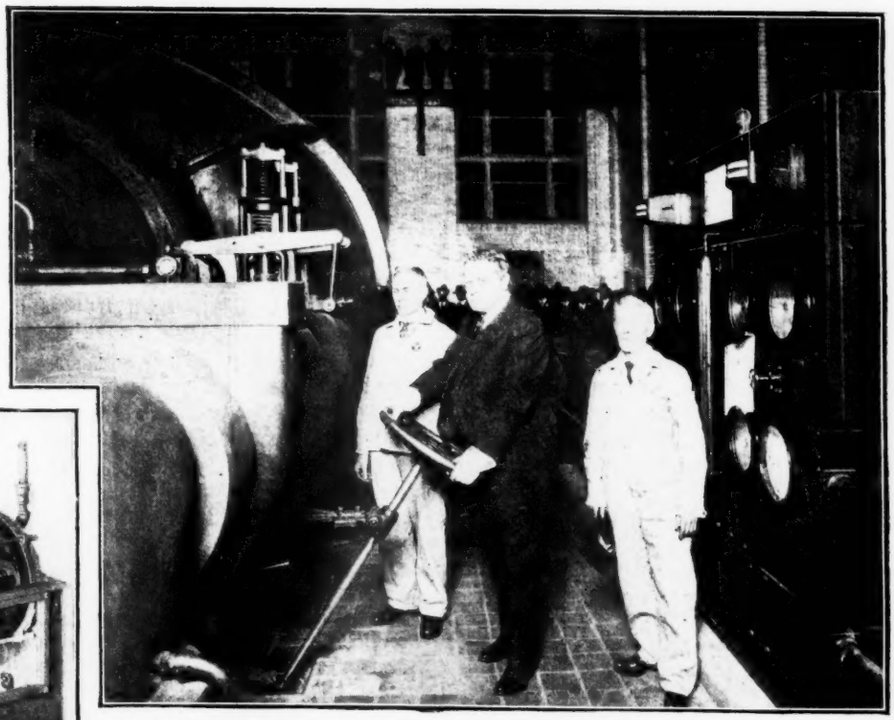
New atmospheric exhaust risers were provided, the 3,000- and 7,500-kva. units exhausting into a common 24-in. spiral riveted steel pipe, rising through the roof, and the other units exhausting into an 18-in. riser running through the west wall.

In connection with the new alternator there was also installed a 35-kw. exciter and necessary switching apparatus. In order to relieve the impedence when all units are in operation and to prevent all units tripping at once, a bus sectionalizing switch is used to divide the main bus into two parts. It is automatic or hand operated, the former when the 7,500 unit is in parallel with the others. Numerous recording instruments, including a 100,000-lb. per hour steam-flow meter, 6-in. venturi meter, draft gages, CO_2 recorder, thermometers, etc., are included.

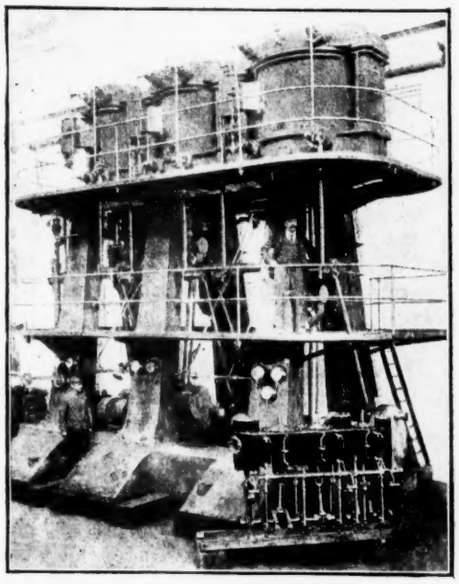
The total cost of the plant was as follows: Boilers, $158,000; stokers, $34,000; 7,500-kva. alternator, $91,000; condensing equipment, $21,000; electrical equipment, $13,000; pumps, heaters, piping, etc., $150,000; structural work, foundations, stack, etc., $151,000; total (with ½ of 1 per cent) $618,000.

Contact drop between carbon brushes and the commutator is about 1 to 1.25 volts. This drop is not proportional to the current, since as the current increases the temperature of the brush increases and its resistance decreases. The drop increases slowly; for instance, with a current density of 20 amperes per sq.in. the drop may be one volt; when the current is increased to 40 amperes, the drop may have increased to 1.25 volts; at 100 amperes the volts drop may be about 1.4, while beyond this point the volts drop may not increase materially.

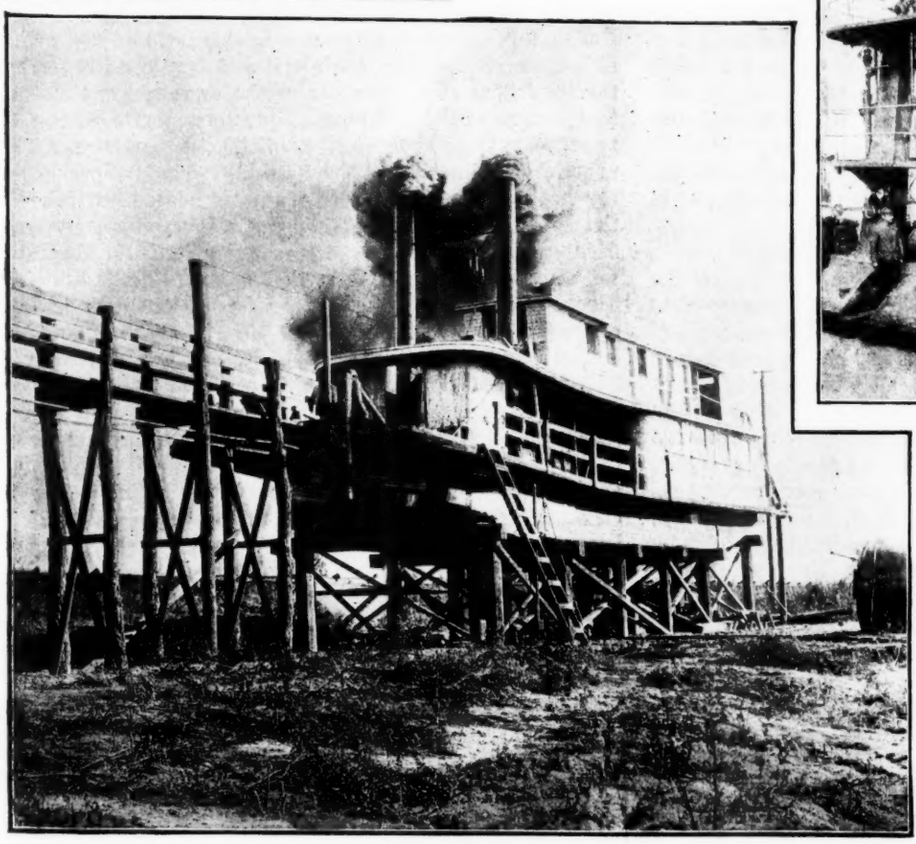
Governor Lake of Connecticut starting up the 20,000-kw. unit at the New South Meadow Station of the Hartford Electric Light Company. At his left is Richard Sheehan, who has been with the company as steam engineer and turbine engineer since 1889, and at his right is Jeremiah Flynn, who has served a year longer as fireman.



The glass boiler shown at the left was made by the Keeler boiler company, and has been exhibited before numerous engineering societies. In operation it shows how the water circulates. There are few such boilers in existence.



These two engines have exactly the same power. Speed makes the difference. The large one is a pumping engine that runs at 16 r.p.m., while the small one is of the torpedo-boat type, and runs at from 500 to 600 r.p.m. The comparison was brought out recently before the Institution of Engineers and Shipbuilders, in Scotland.



This "dry land steamboat" is still doing service as a bunkerage office and power plant for the Standard Oil Company of Louisiana, at New Orleans. Several employees use the rear of the offices as a rooming house, and the power is used for pumping.

Courtesy of the Times-Picayune

Possibilities of the Turbine*

By P. F. COFFIN
Research Department, General Electric Company

SINCE the first Curtis turbines were placed in operation in 1903, the capacities of the largest units have been increased from 5,000 to 45,000 kw., and the steam consumption has been reduced to less than one-half that of the original machines. The efficiency of the turbine generator unit had been increased from 47 or 48 per cent in 1903, to 75 or 78 per cent in 1920. In addition to the increase in size of the units, improvement in steam economy is due to increased thermal range in the steam cycle, higher steam pressure, superheat and vacuum being used. The temperature of the exhaust is limited by the temperature of the cooling water and by the temperature gradient in the metal of the condenser tubes. The latter factor is about 32 deg. F. The steam pressure at the turbine remained at a maximum value of about 200 lb. per sq.in. for a number of years, and the steam was often superheated to a temperature of 550 deg. or 600 deg. F. Future possibilities for increased efficiency lie in further increases in the upper limit of the thermal range:

Efficiency limitations reached in steam turbines, may be overcome by using two vapors in series, such as mercury and steam. A 1,000-kilowatt experimental unit has operated under conditions equivalent to producing 1 kilowatt-hour on about 11,300 B.t.u.

1. By operating with increased steam pressures and superheats with a single turbine.
2. By operating high-pressure and low-pressure turbines in series and re-superheating the steam between the two units.
3. By using a binary vapor cycle with separate turbines operated by the vapors of two substances that boil at different temperatures, such as mercury vapor and steam, the heat of condensation of the mercury vapor being used to generate steam in a condenser boiler.
4. By the development of an efficient gas turbine. No machine of this type, however, has as yet developed high efficiency.

The highest steam pressures in commercial use in the United States range from 250 to 300 lb. at the turbine, while the steam is superheated to temperatures of from 622 deg. to 689 deg. F. These pressures and temperatures, however, have only recently come into use in a few stations. At Joliet, Ill., the Public Service Corporation of Northern Illinois is generating steam under a pressure of 350 lb. at the boiler. This pressure is reduced to 300 lb. at the turbine while being superheated to 622 deg. F. A turbine has been operated at 350 lb. pressure for several years at the works of the British Thomson-Houston Co., Rugby, England. A new station is being built at Manchester, England, which will generate steam at 375 lb., and this will reach the turbine at 350 lb. and with a temperature of 750 deg. F. This station will probably use as high a pressure as can be efficiently utilized in a single turbine, owing to the increasing percentage of condensation during the expansion of steam from higher pressures.

A new station has recently been put in service at North Tees, Middlesboro, England, in which the steam is generated at 475 lb. and reaches the turbine at 450 lb. pressure with a temperature of 700 deg. F. The turbine is divided into two units that operate in series, the steam being re-superheated before use in the low-pressure turbine to minimize condensation. In both the Manchester and Middlesboro stations, the combustion air is preheated about 200 deg. F. by heat from the flue gases. This is a new departure in power-station practice.

The limiting theoretical efficiencies that may be approached in steam-turbine plants, when operating at various steam pressures, are indicated by the curves in the figure. These have been calculated on the basis of the Clausius or Rankine cycle. The lower curve, indicated by a full line, is calculated from the tables of Marks & Davis and of Greene, the specific heat of steam at constant pressure, C_p, being taken from the latter authority. This curve indicates the efficiencies corresponding to an initial temperature of 600 deg. F. and a final pressure of 1 in. of mercury, absolute. The broken line just above is calculated from Goodenough's steam tables and is for the same initial and final conditions. The upper curve is also from Goodenough and is calculated for an initial temperature of 671 degrees.

The Rankine-cycle efficiency is the ratio of the available energy (between the initial and final conditions) to the total heat required to raise the liquid from the final temperature to the boiling point, to vaporize it and to superheat the vapor to the initial temperature. The practical application of the Rankine cycle is represented by the case where the feed water is heated entirely by the sensible heat of the flue gases in economizers and feed-water heaters. At a pressure of 215 lb. absolute, with an initial temperature of 600 deg. F., the limiting theoretical efficiency (according to Goodenough) is 33.3 per cent. At a pressure of 1,000 lb. absolute and an initial temperature of 671 deg. F. limiting efficiency is 39.9 per cent. The first case represents a common practice at the present time, while the second case represents the highest pressure that would be at all likely to be practicable in the future. The actual efficiencies attainable in either case differ from the limiting efficiencies by the amount of the thermal and mechanical losses, and their proportion will presumably increase with the higher temperatures and pressures.

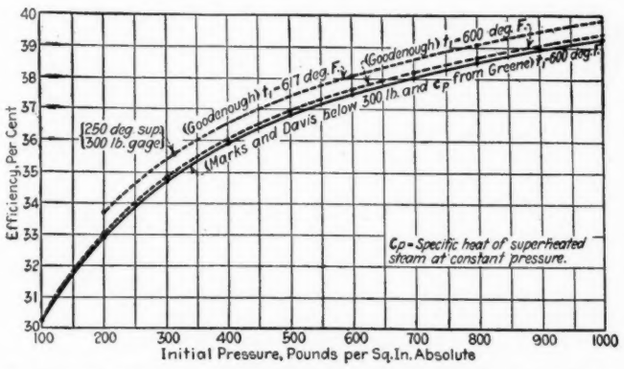
The Rankine-cycle efficiency is lower than that of the Carnot cycle, and this difference becomes greater as the steam pressure increases. Many of the more modern stations operate on a cycle that is between the Carnot and Rankine cycles. It differs from the latter in the fact that the feed water is heated regeneratively, in part at least. This is accomplished by the use of exhaust steam from the auxiliaries or by bleeding steam from the main units before it has completed its expansion. The use of such intermediate cycles makes it

*From the author's contribution, "The Utilization of Coal on a Multiple-Products Basis," to R. F. Bacon's and W. A. Hamor's forthcoming book "American Fuels."

possible to offset some of the losses which detract, in practice, from the theoretical thermal efficiency.

The maximum practicable operating pressure remains to be determined, but it will doubtless lie somewhere between the pressures of 600 and 1,000 lb. per sq.in. The possible gain in efficiency is important in the case of base-load service, where the saving in fuel should more than offset the fixed charges incident to the additional investment required.

When operating over a large temperature range with a single vapor, pressure limitations are soon reached,



RANKINE-CYCLE EFFICIENCIES FOR VARIOUS INITIAL PRESSURES AND FINAL PRESSURE OF ONE INCH OF MERCURY

and in the case of steam the low density and high latent heat of vaporization give rise to high spouting velocities. This necessitates a large number of stages in the turbine to secure good efficiency.

Using Two Vapors in Series

Higher efficiencies may be more readily obtained by using two vapors in series, such as mercury and steam. Mercury vapor has a much greater density than steam and a lower heat of vaporization; hence the spouting velocity is low and it may be used in a high-temperature turbine of very simple design. A mercury turbine and boiler are being developed by the General Electric Co., under the direction of W. L. R. Emmet. The first large experimental unit has been operated for several weeks at loads up to 1,000 kw. on the mercury turbine. This problem is receiving intensive study at the present time and gives promise of practical results in the way of a successful prime mover with an efficiency comparable with that of the Diesel engine.

Moreover, this high efficiency may be attained with solid fuels, whereas the Diesel engine is limited to oil. The fuel will be burned, by any standard method, in the furnace of the mercury boiler. In central stations the present steam turbines can be used and only the boilers need be removed and replaced by the mercury equipment. On ships the mercury and steam equipment may be used for propulsion in connection with electric drive to the propellers. This will place solid fuels on a par with liquid fuels as far as efficiency is concerned, and all the arguments for the preparation of solid fuels for steam boilers will hold good also for mercury.

The 1,000-kw. experimental unit has been operated under conditions that are equivalent to a coal consumption of about 11,300 B.t.u. per kw.-hr., assuming that the steam produced is used as efficiently as in the best power stations. A consumption of 18,000 B.t.u. is considered extremely good economy in large steam stations at the present time. In the tests mentioned, the mercury vapor was generated under 11 lb. gage pressure. A smaller mercury boiler of improved design has been operated under pressures up to 35 lb. gage, which should give a higher efficiency.

Safety Hints for the Engineer

Perhaps the old saying, "Familiarity breeds contempt" holds true nowhere so strongly as in the power plant, where a man grows accustomed to handling thousands of horsepower with no more uneasiness than the small boy with his bicycle. It is therefore well occasionally to remember the simple precautions that are quite generally understood but often disregarded, and so some suggestions given in a recent issue of the *Travelers Standard*, may well be mentioned here.

The advice given to engineers to locate immediately the cause of any unusual noise in an engine seems almost superfluous, as anyone who takes any pride in his work will lose no time in finding out where any strange sound comes from; but the suggestion that periodical inspection of engines should be made, is one that should doubtless be followed more closely by many engineers. Thorough, systematic inspection will often make it possible to find trouble before it becomes serious, and thereby to save money and perhaps a shutdown.

About the most serious accident that can happen to an engine is a flywheel explosion, which generally results from trouble in some part of the governor. Hence, that device should be given especial attention. In the case of a belt-driven governor the belt must be kept in good condition and without slip and the pulley tight on the shaft. Failure to remove the stop-pin from the governor stand has caused more than one engine accident, and any adjustment that will prevent the governor's operation is, quite plainly, a gamble against long odds. Oil only, never heavy grease, should be used in the oil pots of a governor.

It might well be added here that it is not safe to be satisfied with the operation of a governor just because it controls the engine properly under normal operating conditions, for an accident in some other part of the plant will sometimes throw off the entire load suddenly, under which circumstances a sluggish governor may make work for the undertaker.

Another thing to remember is that pieces of rubber gaskets or other objects that may be left in a pipe when making up joints may be carried through to the governor valve and cause trouble there.

Remote-control devices, independent safety stops, relief valves and other automatic devices are recommended, but they are likely to give a false feeling of safety unless tested fairly frequently. Wrecks have often been caused by relying on such devices when they have not been kept in condition and therefore failed to operate.

It is generally easy and always wise not to stand in front of the cylinder head when the steam is turned on. It is likewise prudent, before opening up a cylinder to remove the piston or for other reasons, to try the indicator cocks to see that there is no pressure. Relief valves should be placed where they will not scald anyone when they operate.

The engineer that pays a little attention to details like this gives himself a better chance of reaching a ripe old age and at the same time makes himself more valuable to his employer by preventing costly accidents, which may easily cost thousands of dollars.

Lubrication—Specific Gravity

By W. F. OSBORNE*

ONE of the very useful physical characteristics of petroleum is its gravity. It is probably the first property to be measured, and yet the term is frequently misused. When we speak of the gravity of a liquid, we mean the ratio of its density to the density of water. Strictly speaking, the specific gravity of an oil is the ratio of the weight of a given volume to the weight of an equal volume of water at the same temperature. It is a common practice in the oil industry to take the gravity readings at 60 deg. F. as compared with water at 60 deg. F. rather than at 4 deg. centigrade, the temperature normally used in comparing densities of other liquids.

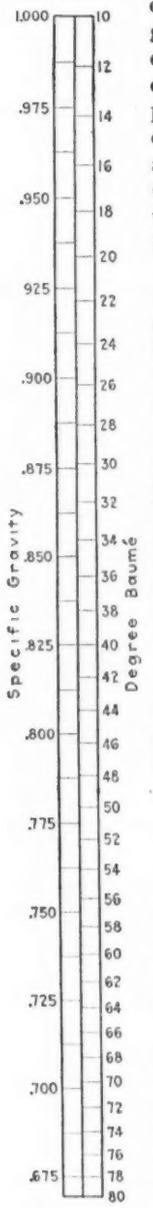


FIG. 1. SPECIFIC GRAVITY—BAUMÉ

In addition to the specific gravity there is another gravity scale, called the Baumé scale, and it is the readings on this scale that are almost invariably used in the refining and marketing of petroleum products when specifying the gravity of an oil.

There are at the present time two Baumé scales in use in this country, slightly differing in the relative values of their readings as compared with the actual specific gravities. One scale adopted by the United States Bureau of Standards is in accordance with the formula,

$$\textit{Specific gravity} = \frac{140}{130 + \textit{Bé. reading}}$$

The other scale called the Tagliabue-Baumé scale, has been adopted by the National Petroleum Association and is based on the formula,

$$\textit{Specific gravity} = \frac{141.5}{131.5 + \textit{Bé. reading}}$$

The latter formula, on account of its general acceptance throughout the oil industry, will be used as the basis of all calculations in succeeding articles. The relation of specific gravity to Baumé is shown in Fig. 1.

Baumé gravities are usually measured directly by means of an instrument known as a hydrometer, calibrated to read in the Baumé scale. The test is made by immersing the hydrometer in the oil and allowing it to remain long enough to come to rest. The proper method of reading the hydrometer is shown in Fig. 2.

Some hydrometers are graduated to read specific gravities directly. Other instruments used to measure specific gravities are the picnometer, Westfal balance, etc., when greater accuracy than can be secured with the hydrometer is required. Heavy fuel oils are difficult to measure with the hydrometer on account of the high viscosity or frictional resistance preventing the hydrometer from sinking to the correct depth.

All oils expand or contract as the temperature rises or falls, and since the hydrometer measures the gravity corresponding to the temperature of the oil, it is necessary to correct the reading to its equivalent at 60 deg. F. The hydrometer usually carries a thermometer with a correction scale marked on it. The correction is made by adding to the observed Baumé reading when the temperature is below 60 deg. F. and subtracting when the temperature is above 60 deg. F. For all practical purposes the following corrections are satisfactory: Lubricating oils, 1 deg. Bé. for every 20 deg. F.; gasoline and kerosene, 1 deg. Bé. for every 1 deg. F.

The gravity reading has many valuable uses. Crude oil is purchased by the refiner on a basis of gravity. To

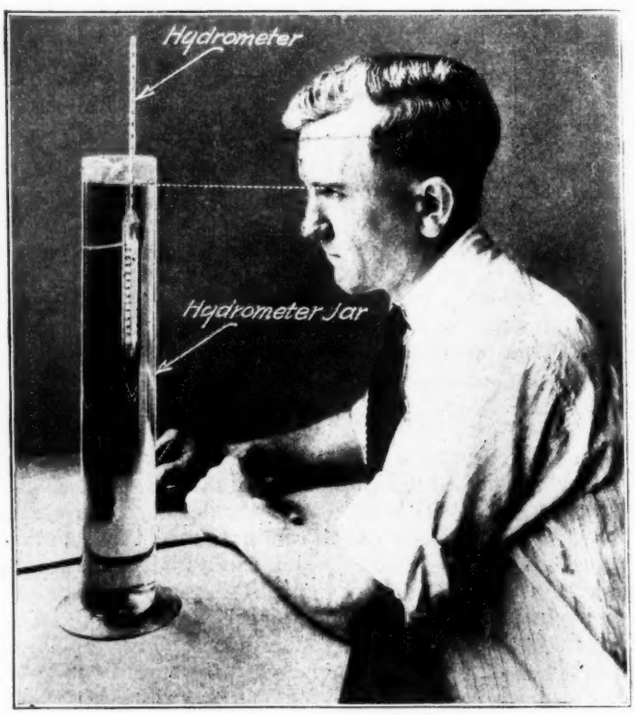


FIG. 2. PROPER METHOD OF READING HYDROMETER

the experienced oil man the gravity reveals fairly well what finished products can be made from the crude and from what field it was secured.

To the oil user the gravity reading is of value as it frequently gives him an idea of the crude from which the oil was made and thereby an inkling of other properties the oil might be expected to possess. Standing alone, the gravity reading is of no value whatever in the selection of lubricating oils, and is of practically no value in the purchase of gasoline or fuel oil unless accompanied by other tests.

It is valuable and necessary in checking the quantity of oils purchased on account of the expansion with temperature increases, as will be explained in the next article.

Q. What is the specific gravity of an oil having a Baumé gravity of 27.8?

A. $Sp.gr. = \frac{141.5}{131.5 + Bé} = \frac{141.5}{131.5 + 27.8} = 0.8883.$

*Supervisor Manufacturers' Service, Texas Company.

The Necessity for and Savings Possible with Better Boiler-Room Operation*

By C. W. DeFOREST
Manager, Electrical Department, Union Gas and Electric Company, Cincinnati, Ohio

THE boiler room is only one of the links in the chain of operations involved in transforming the energy stored in our coal resources into the electrical energy furnished to consumers. During the recent past the attention of engineers has been frequently called to the fact that the efficiency of modern boiler-room practice is much higher than the efficiency of producing and mining coal and of converting the energy of the steam into electrical energy. It might seem, therefore, that attention should be concentrated particularly upon those links in the chain of operations involved in transforming the latent energy of coal into electrical energy available to consumers, where the greatest returns can be obtained from a given expenditure. But while this is true and is becoming more and more apparent, it can be shown that the possible increase in efficiency in many of our boiler plants more than justifies the necessary expenditure involved.

The three principal factors that go to make up the cost of producing electrical energy, from the coal pile at the generating station to the busbars, are: (1) Investment cost; (2) cost of fuel; (3) organization, personnel, supplies and maintenance costs. To simplify

STEAM TURBINE N92

Every 7 days
Test out trip for overspeed; look for loose bolts in overspeed trip; inspect "Squealer" plates. Operate vacuum breaker.

STEAM TURBINE N92

Maker.....General Electric Co., Schenectady, N.Y
Proposal Date.....Feb 18, 1916
Type.....ATB Curtis, horizontal, single cylinder, 17 stage impulse, steam generating unit.
Specifications.....60 cycle; 3 phase; 5 pole; 1800 r.p.m; 13,200 volts, 25,000 K.W. at 80% P.F., or 31,250 K.V.A. 1368 amps per phase at 80% P.F., 140 K.W. at 250 volts being required for excitation
Steam Cons'pt. guarantees..Based on steam pressure of 230 lb. per sq.in. Superheat, 200° F. back pressure in exhaust chambers - 1" absolute
K.W. output - 15,000 - 20,000 - 22,000 - 30,000
Water Rate 11.15 10.70 10.69 10.80
Overall Dimensions...Length 48.6 & width 19.7', height 12'-6" Floor space 950 sq.ft. Floor space per K.W. rating 0.038 sq.ft. Net Wt. 652,000 lb Net weight per K.W. rating 26.1 lb.
Serial No.....12363
Put in Service.....Nov. 4, 1918

FIG. 1. APPARATUS CARDS

the problem, the first factor may be left out of consideration in this discussion and the plant and equipment assumed to be properly designed and installed.

Cost of Fuel

Let us suppose that we have a modern station of about 100,000-kw. capacity, consisting of turbo-generator units of from 20,000 to 35,000 kw. each, and a boiler plant equipped with boilers, each with 10,000 sq.ft. heating surface, operating at steam pressures of 250 to 300 lb., and a total steam temperature of from 600 to 700 deg. F. Such a plant, with a good load factor, should have a station water rate of 12 lb. per kw.-hr. What are the factors that determine the

TURBINE NO. 2

DATE	W.O.No.	TRIPPING MECHANISM
2-20-21	50	Tested overspeed trip
2-28-21	178	Inspected bolts on squealers and vacuum-inspected piping - Trip not tested
3-6-21	296	Put weight on emergency governor - Tripped at 1720 R.P.M.
3-9-21	330	Tried out tripping levers when turbine was shut down. Inspected bolts
3-13-21	373	Inspected bolts and mechanism on governor - Looked O.K.
3-14-21	388	No work done
4-13-21	743	Overspeed trip operated at 1700 R.P.M. Bolts, trip and squeeler plates O.K.
4-27-21	945	Overspeed trip operated at 1700 - Bolts, trip and squeeler plates O.K.
5-10-21	1125	Tested overspeed - went out at 1720 R.P.M.
5-24-21	1291	Overspeed trip operated at 1720 R.P.M. Squealer plates O.K.
7-5-21	1762	Tripped at 1720 R.P.M. All bolts tight. Squealer ring O.K.
7-30-21	1938	Tripped at 1700 R.P.M. Bolts & mechanism O.K. Vacuum breaker operated O.K.
8-16-21	2220	Tripped at 1700 R.P.M. Squealer plates O.K.
8-19-21	2321	Tripped at 1710 R.P.M. Bolts O.K. Squealer plates O.K.
8-24-21	2419	Tripped at 1720 R.P.M. Vacuum breaker - Squealer plates O.K.
8-28-21	2530	Tripped at 1720 R.P.M. Bolts, squealer plates O.K. Operated Vacuum Brake O.K.
9-7-21	2629	Tripped at 1720 R.P.M. Bolts, Squealer plates O.K. Vacuum breaker O.K.

FIG. 2. INSPECTION CARD

unit cost of energy? Table I shows how the various factors based on $4 coal enter into the total cost.

From the table it is seen that the fuel cost at $4 per ton is 76.8 per cent of the total; at $5 per ton, 80.5 per cent; at $6 per ton, 83.2 per cent. These figures are for a plant capacity factor of 41.2 per cent. As this factor is increased, the percentage of cost per kilowatt-hour, due to fuel, will increase. These figures should bring out clearly the necessity for continued

TABLE I. COST OF POWER PRODUCTION

	Per Cent of Total Cost per Kw.-Hr.
Superintendence, clerical and efficiency dept.	2.00
Boiler-room operation, including ash disposal	5.12
Boiler-room repairs	3.80
Engine-room operation, including electrical labor	4.60
Engine-room repairs	3.07
Miscellaneous expense	4.61
Coal, at $4 per ton	76.8
Coal, at $5 per ton	80.5
Coal, at $6 per ton	83.2

effort to secure better boiler-room operation. Where the cost of producing a kilowatt-hour is higher, the necessity for saving will be more apparent.

Watching Operations and Making Adjustments

Given turbines and generators of definite characteristics, it is comparatively easy to watch operations and to make the necessary adjustments to maintain satisfactory operating conditions. But the production of the steam, which represents from 76.8 per cent to 83 or 85 per cent of the total cost, is carried out under conditions that are constantly changing. The losses taking place are doing so minute by minute and, like "water through the mill," once lost, cannot be recovered.

Let us review the factors entering into the cost of Boiler-room operation. Table II shows a typical "set-up" of the gross cost of boiler-room labor.

Table II shows that the cost of stoker engineers or firemen, including the time of the assistant superintendent actually given to boiler-room operation, is only $2,130 per month, or 1.55 per cent of the total, and the

*Extract of paper read before the Stoker Manufacturers Association at Shawnee-on-the-Delaware.

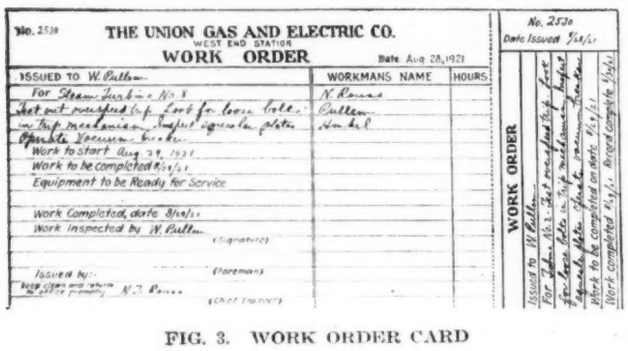
cost of superintendence and clerical work is only 3.25 per cent of the total cost of power-house operation.

We have a proposition where the labor, which is only 2 to 3 per cent of our cost, controls 80 per cent of the cost of producing steam.

The only way to gain that last 2 to 5 per cent in boiler efficiency is by constant, efficient watchfulness on the part of the stoker engineers, boiler-room foreman and the efficiency engineer, and we cannot afford to employ cheap, inferior men in the boiler room.

Organization and Co-operation

In order to get results, we must have the real, genuine co-operation of the men. They must be personally interested in their work and its results, and


No. 2530 THE UNION GAS AND ELECTRIC CO. WEST END STATION WORK ORDER Date Aug 28,1921

ISSUED TO W. Bullen — WORKMANS NAME — HOURS

For Steam Turbine No. 8
Shut out pumping Unit Look for loose bolts
in Trip mechanism Inspect governor plates
Operate Governor Gear
Work to start Aug 29, 1921
Work to be completed 8/31/21
Equipment to be Ready for Service
Work Completed, date 8/31/21
Work Inspected by W. Bullen (Signature)
Issued by: (Foreman)
Time slips are given to office promptly N. J. Powers (Chief Engineer)

No. 2530 Date Issued 8/29/21
WORK ORDER
Issued to W. Bullen
For Steam Turbine No. 8 Shut out pumping Unit Look for loose bolts in Trip mechanism Inspect governor plates Operate Governor Gear
Work to be completed on date 8/31/21
Work completed 8/31/21 Record complete 9/1/21

FIG. 3. WORK ORDER CARD

to obtain this end, the conditions under which they work must be pleasant, their wage must be adequate and they should be kept in touch with the results of their efforts.

Our company does not hire experienced firemen. It tries to select clean, bright young men with brains, regardless of former experience in the boiler room.

TABLE II. LABOR COSTS

	Cost per Month
Stoker engineers and firemen	$1,980.00
Water tender	420.00
Heater tender	378.00
Economizer tenders	624.00
Oiler	120.00
Instrument attendant	240.00
Relief men	284.00
Blowing soot, boring tubes, inspection, cleaning boiler room and apparatus	1,600.00
Proportion of time of assistant to superintendent and chief engineer	150.00
Total cost boiler-room operation	$5,796.00

Upon employing a man, he is put in as boiler-room helper, then as economizer tender, heater tender, on boiler-maintenance work, and finally on stoker operation or firing.

We conduct two classes a week, at different hours, which it is compulsory to attend. The class is conducted by a professor of mechanical engineering from the University of Cincinnati, assisted by our superintendent of production and efficiency engineer. The men are taught the principles of combustion engineering and elementary mechanical engineering, as especially applied to the equipment in our station.

Boiler-Room Instruments

The instrument equipment enables us to have a full knowledge of the draft conditions and temperatures throughout the furnace, boiler and economizer, the steam flow, the pounds and quality of coal used by each boiler and, by sampling and analysis, the amount of combustible in the ash. All instruments are carefully maintained and the records compiled daily. After these records are obtained, they are analyzed, and every effort is made to apply the information thus recorded, to maintain our highest standard of performance and, if possible, improve it.

Each day we know the efficiency obtained by each boiler and the general performance of each pass and part of the boiler, from the furnace on up through the economizer. This information is compiled in useful shape daily and checked by the efficiency engineer and the superintendent of production, and readily shows any furnace, boiler or economizer that is falling off in efficiency, as well as the reason for this condition.

By proper management it is not necessary to use the time of the engineering staff for the detailed routine work of preparing the data for use. The work of planimetering the records and entering the results in proper form on the daily performance record is practically all done by one woman. We have tried men, but usually young men with the required mental equipment will not remain on work of this character as, naturally, they want to progress, but a woman will stick to it except for a wedding, and girls are more deft and soon become expert. The nature of the work is such that it is not difficult to train the kind of woman who is capable of high-grade stenographic work, but in the selection due regard should be given to those possessing mechanical tendencies.

Boiler-Room Records

I would rather keep too many records than too few. The total cost of our record work, including the electrical daily log sheets, records of feeder output and complete turbine-room and boiler-room records, including stationery and forms, is $7,700 a year, and what business totaling $1,800,000 per year expenses would not spend more than four-tenths of one per cent for accounting and cost keeping, particularly when it is one of the vital factors in maintaining standards of operation. Satisfactory operation is not usually secured by using the time of engineering talent at desk work. We find that the best results are obtained when our engineers are out in the boiler room, applying the information to get results. Boiler-room records and accounting can be as readily kept as cost records in any other business.

If we expect to keep a boiler plant up to an average efficiency of from 75 to 80 per cent, the plant as a whole must be well maintained. How often we find that equipment will give high economy when new, but that the efficiency drops off after a year's use. It is needless to go over the long list of conditions that must be looked after in a boiler plant. But manufacturers know from long experience that apparatus will usually meet the guarantees when new and tested by the manufacturers' engineers, only to fall off when left to the care of the station operators. From this it is apparent that lack of proper maintenance inevitably involves inefficient operation, and that the fault generally lies with the operating force or the management.

The modern power house, with its multiplicity of auxiliary apparatus, and being worked at increasingly higher stresses, cannot be left to haphazard inspection and maintenance. Record-filing systems have been devised for performing this function, and it has been demonstrated that they are less liable to error than the most conscientious employee. It is not sufficient that a record be kept of when repair work was performed. A system must be used to insure the regular

periodic inspection and maintenance of every piece of equipment.

The plan we have adopted is to have a card for every boiler, stoker, economizer, motor, pump, all principal valves, switches, cables and every other separate piece of equipment.

They are kept in a file, arranged according to date and distributed so that a certain number of cards are handled each day. One man is responsible for the proper handling of the cards and work orders. Each day the cards covering the apparatus to be inspected or repaired, are taken out and a specific work order issued for each piece of equipment; a perforated stub bearing the same number as the work order is retained by the maintenance clerk.

After the inspection or repair is completed, the work orders are filled out, showing the work done, time spent on the job, etc., and returned to the chief engineer, who personally inspects the work to see that it has been done according to the order. By this arrangement the chief engineer and his assistants can use their time most effectively—no filing system can perform this function.

The information covering inspection, repairs made and time spent on the work is entered on separate apparatus cards, which form a permanent record of maintenance. The cards in Figs. 1 to 3 show the form of apparatus cards, work orders and apparatus record cards used.

Ray Elastic Disc Expansion Joint

Because piping systems invariably extend between rigidly fixed points, it has been found advisable to employ some kind of expansion joint to care for the lengthening and shortening of the piping resulting from changes of temperature. Various designs of expansion joints have been in use in years past, and new ones make their appearance from time to time, one of the latest being the Ray elastic disc expansion joint, shown in Fig. 1, manufactured by the Ray Expansion Joint Co., Inc., 95 Liberty St., New York City.

This joint consists of two flanges connected together by means of a flexible element, the flanges being guided relatively to each other so as to permit longitudinal movement while preventing lateral movement. This longitudinal movement of the flanges is secured through the bending of the metal of the flexible element, which consists of a number of corrugated steel disks alternately welded together at their inner and outer circumferences, the end disks being provided with enlarged flanges for attaching to the flange end pieces. The discs are pressed from plates of crucible nickel steel which, when subjected to a heat treatment that is given the completed element, has an elastic limit of approximately 170,000 lb. per sq.in. and an ultimate strength of about 220,000 lb. The disks are mounted in pairs and rotated during the welding process, the inner seams being welded first; they are then assembled, and the outer seams are welded by an electric arc system. Fig. 2 shows a typical weld.

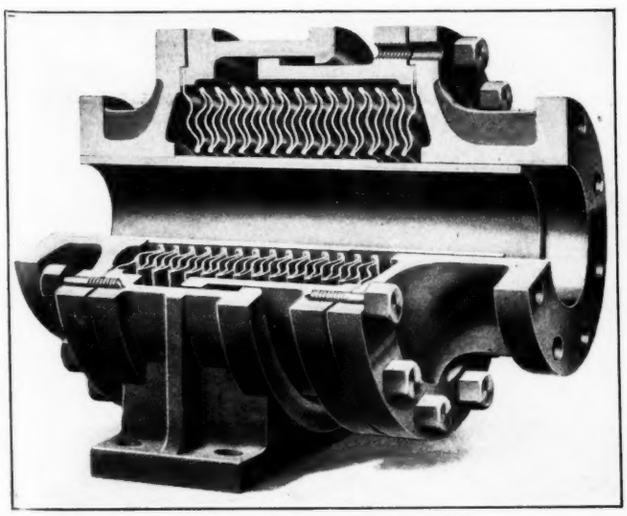


FIG. 1. EXPANSION JOINT SHOWING WELDED CORRUGATED DISCS

FIG. 2. SHOWING WELDED DISC ENDS

Because of the construction of the elastic element of the joint, the stresses set up in the plate by both pressure and movement in the welds joining the plates is as great as in the plates themselves, therefore the welds are made with an elastic limit and ultimate strength as great as the plates so as to utilize in full the elastic limit of the metal of the plates.

As shown by Fig. 1, the outer casing protects the disks and also acts as a stop for the movement of the joint in both directions, thus preventing the movement of the elastic element from exceeding the elastic limit under any conditions of use. A tube on the inside of the elastic element has one end forced into one of the flanged heads, the other end making a close sliding fit with the other movable head. This tube not only acts as a guide, but prevents the escape of any considerable amount of steam in case of breakage of the elastic element.

This joint is made in standard size for 125 lb. pressure and for high pressures up to 250 lb., with expansion of 3 and 2 in. respectively. The joint can be made up to 16-in. size.

The Steam-Engine Indicator

What a Reducing Rig Is and How It Is Made

THE paper drums of steam-engine indicators range from 1¼ to 2 in. in diameter, giving, after allowing for the width of the retaining clips, a diagram with a length of from 3½ to 5 in. This diagram length, of course, is far less than the piston stroke of any but model engines. Steps must then be taken to obtain some arrangement whereby the stroke of the engine piston, when transmitted to the travel of the indicator cord, reduces the latter to from 3 to 5 inches.

The most obvious way for vertical or horizontal center-crank engines is shown in Fig. 1, where a small crank having a stroke of, say, 4 inches is connected to a small piston rod and crosshead by a connecting rod, which, for example, with a 24-in. stroke, is $\frac{4}{24}$ as long as the engine connecting rod. This reducing motion is set in line with the engine crank. If the engine piston is forced along the cylinder by the steam, the motion is transmitted to the engine crank, which moves through an angle depending on the distance the piston has moved. The reducing-motion crank rod moves through the same angle and shifts the reducing-motion crosshead and piston a certain amount, which bears the same ratio to the engine piston travel as the small crank throw bears to the engine crank throw, since all parts bear the same ratio to the corresponding engine parts.

In the geometrical diagram of this motion OA is the raidus of the small crank, OB the engine crank BD the

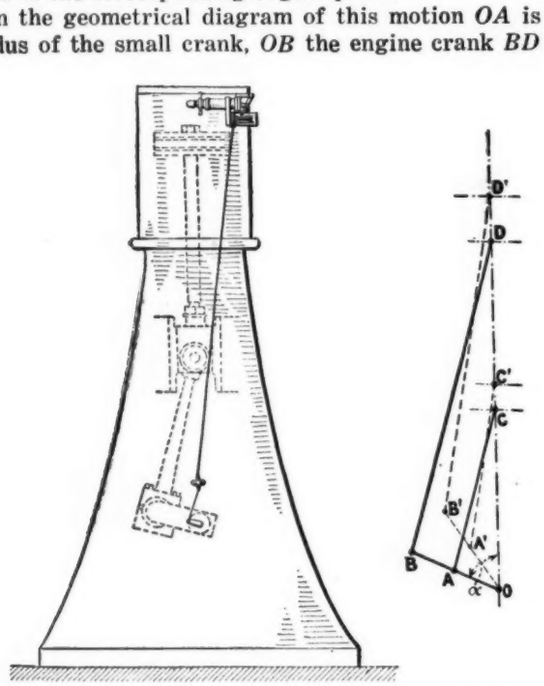


FIG. 1. SIMPLE RIG FOR CENTER-CRANK ENGINES

engine connecting rod and AC the reducing-motion connecting rod. By construction $\frac{OA}{OB} = \frac{AC}{BD}$. In the two triangles OBD and OAC we have the two corresponding sides parallel and the included angle α the same, consequently AC and BD are parallel and OC bears the same ratio to OD as OB to OA or $\frac{OC}{OD} = \frac{OA}{OB}$. If the cranks are moved to a new position OB', we have the new triangles $OB'D'$ and $OA'C'$ and for the reasons given $\frac{OC'}{OD'} = \frac{OA'}{OB'}$ or $\frac{OA}{OB} = \frac{OC + CC'}{OD + DD'}$, but $\frac{OA}{OB} = \frac{OC}{OD}$; then $\frac{OA}{OB} = \frac{CC'}{DD'}$, and since CC' and DD' are the motions of the two crossheads, we find that the engine crosshead

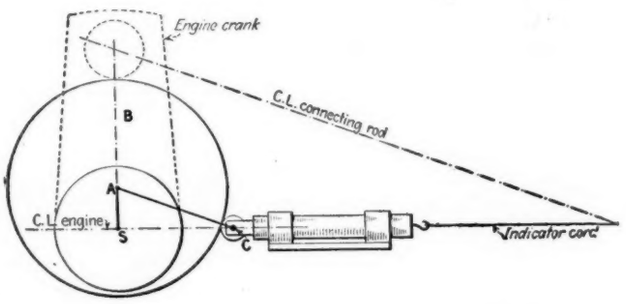


FIG. 2. ECCENTRIC RIG FREE OF ERROR

travel bears the same relation to the indicator cord and drum travel as the relation of the two cranks.

Any engineer can easily make the parts of pipe fittings, babbitting the slide to give a close fit to the crosshead, which may be a piece of cold-rolled shafting drilled to receive the wristpin. The connecting rod may be a piece of flat steel drilled for the pins and the holes babbitted or fitted with small brass bushings.

A somewhat similar device is shown in Fig. 2, where an eccentric B is clamped to the engine shaft with the eccentric throw SA in line with the engine crank. In constructing this motion the relation of the radius of the eccentric B plus the radius of the roller C (the distance AC) to the engine connecting rod is equal to the ratio of the eccentric throw to the engine crank throw or

$$\frac{AC}{\text{Connecting rod}} = \frac{AS}{\text{Crank throw}}.$$

The pantograph reducing motion has been largely used on slow-speed engines. This design is shown in Fig. 3. Here we have a frame of four strips forming a rectangle $EFDB$ with jointed corners. If this has the side BD extended and connected to the engine crosshead at C while the end A is swung from a point above the engine, it is apparent that when the piston moves along its stroke the point C will move to C' and the pantograph will assume the position shown. The line CC' represents the distance the crosshead has moved. It remains to show that if an indicator cord be posted at F, the length FF', which is the travel of the indicator cord, will give the ratio $= \frac{CC'}{FF'} = \frac{AC}{AF} = \frac{AC'}{AF'}$. Taking the triangles ABC and AEF, we find that they are similar since the corresponding sides of the triangles are parallel by construction. On swinging the frame so that C is at C', we have the triangle $AE'F'$ and $AB'C'$. The ratio of the sides $\frac{AE'}{AB'} = \frac{B'C'}{E'F'}$ is still the same, since the length of

these sides is not changed by the motion of the frame. Also $E'F'$ is parallel to $B'D'$, since they are equal sides of a figure having by construction the other two sides $B'E'$ and $F'D'$ equal. Then $E'F'$ is parallel to $B'C'$, and we have the triangles $AB'C'$ with all three sides parallel to corresponding sides of the triangle $AE'F'$. Then $\frac{A'C'}{AF'} = \frac{B'C'}{E'F'} = \frac{BC}{EF}$, and it follows that

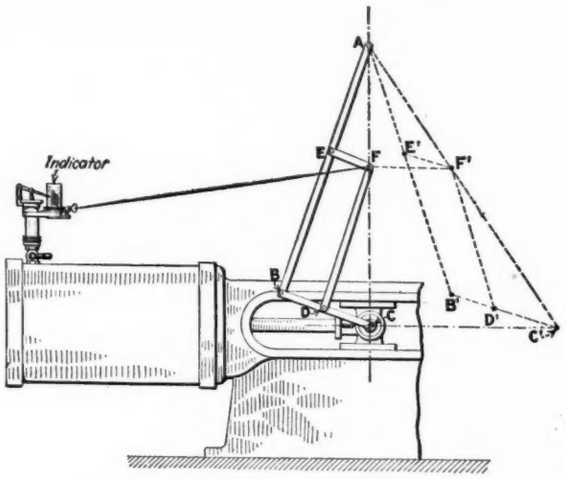


FIG. 3. PANTOGRAPH REDUCING RIG

$\frac{A'C'}{AF'} = \frac{AC}{AF}$. The triangles ACC' and AFF' are similar, and the side FF' is parallel to CC', the travel of the engine crosshead. Consequently, the distance FF' is proportional to CC', and if an indicator cord is fastened to the point F the travel of the cord from F to any point F' is proportional to the travel of the engine cross-

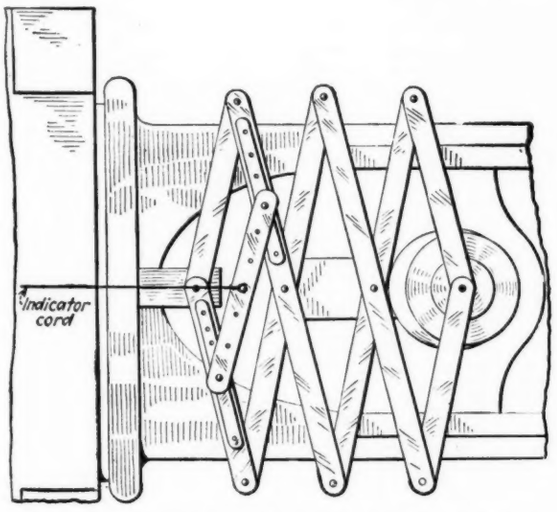


FIG. 4. COMMON FORM OF PANTOGRAPH RIG

head from C to any point C'. The ratio of indicator-cord travel to crosshead travel is equal to the ratio of AE to AB. This rig has been used on slow-speed engines, but the pantograph shown in Fig. 4 operating on the same principle is more often employed. Due to the many pin connections the pantograph is to be avoided, although the indicator drum travel is an accurate representation of the engine piston travel as long as no lost motion exists.

Another rig formerly much used is shown in Fig. 5. This consists of a swinging pendulum or lever OM having a pin A which rests in a slotted plate fastened to the crosshead. The indicator cord is attached to a pin B. The motion given to the indicator if the indicator cord is, say, ten times the drum travel, is in close relation to the piston travel, as is shown in the geometrical diagram, where OM is the lever length, OB the distance to the indicator pin, S the piston stroke and BB' the travel of the indicator. As the crosshead travels from A to M', the distance traveled is $S = AM'$, which is the vertical projection of the arc of travel MM' of the lever pin M. Likewise S' is the vertical projection of the arc traversed by B, the indicator cord pin, from B to B But $\frac{OB}{OM} = \frac{OB'}{OM'}$ by construction, since these measurements are fixed, and the angle is the same for the two triangles BOB' and MOM'. The triangles

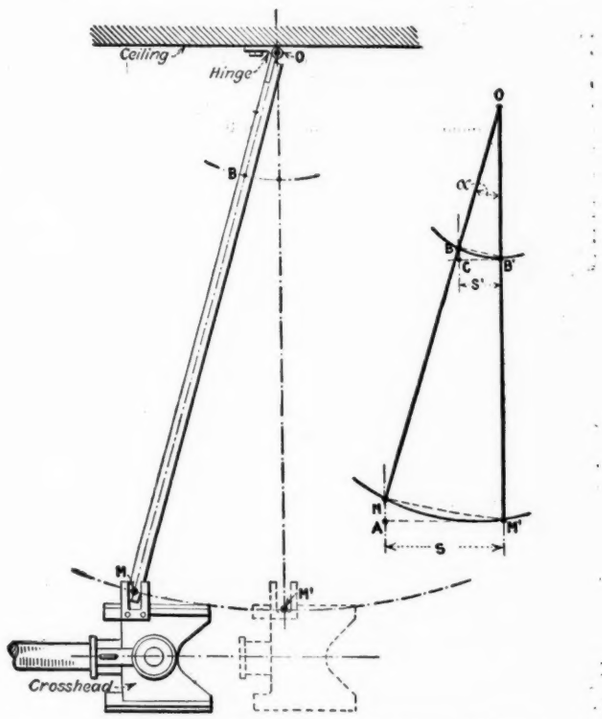


FIG. 5. REDUCING RIG WITH A SLIGHT ERROR

OBB' and OMM' are then similar. The angle $CB'B$ is equal to the angle $AM'M$ since the corresponding sides are parallel. AM and AM' are parallel to the corresponding sides of the triangle BCB; then $\frac{CB'}{AM'} = \frac{BB'}{MM'} = \frac{OB}{OM}$, which means that the horizontal travel of B and of the indicator cord is in proportion to the crosshead travel, and if the cord is long in proportion to the drum travel, say a ratio of 10 to 1, and the lever is three to four times the piston stroke, the error in the diagram due to the vertical movement of the cord will be negligible, amounting with this ratio to 0.02 in. in the diagram length. This does not hold true if a Brumbo pulley be used instead of a pin at B; the error in this case is considerable.

For slow-speed engines such as a standard Corliss the arrangement shown in Fig. 6 is very suitable. As indi-

cated, the rig consists of two light grooved wheels about which is wrapped a cord. This cord is attached at *C* to a standard attached to the crosshead. The wheel *W* is mounted on a spindle carrying a second pulley *H* of small diameter, and about this small wheel is wrapped the indicator cord. It is obvious that as the crosshead moves, the travel of the cord and standard *C* will revolve the wheel *W*, which in turn will rotate the small pulley

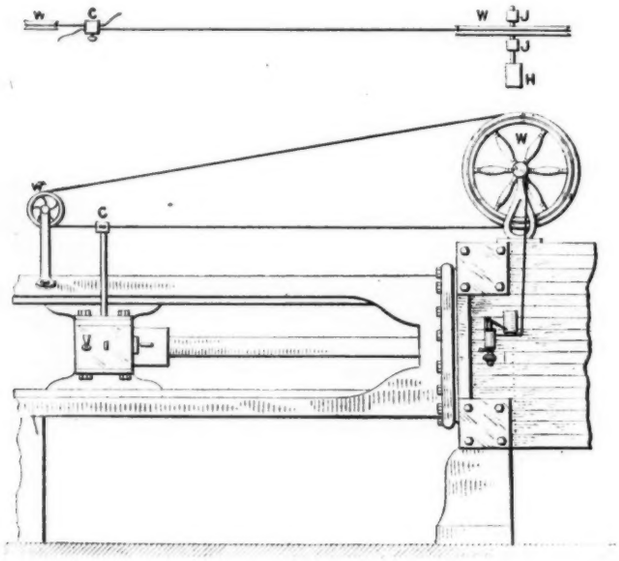


FIG. 6. RIG SUITABLE FOR LONG-STROKE ENGINES

H, giving a travel to the indicator cord and drum in ratio to the crosshead travel as the diameter of the pulley *H* bears to the diameter of the pulley *W*, or

$$\frac{\text{Diameter } W}{\text{Diameter } H} = \frac{\text{Engine stroke}}{\text{Drum travel}}$$

The advantage of this rig lies in its giving a true representation of the piston travel and in avoidance of the overtravel of the indicator since the cord *D* is positively controlled by the crosshead.

The Story of a Hot Pursuit of Air Leaks with an Orsat Apparatus

The following is a story of the actual experience of an engineer who used his Orsat as a sort of Sherlock Holmes to locate defects in his boiler settings. The incident is true and happened recently, but the man's identity will be concealed under the assumed name of Smith.

Smith had been worrying himself nearly sick over the CO_2 that he was getting, which at times went as low as 4 per cent. To ease his mind, he took his Orsat and went after the trouble, resolving to locate it and slay it in its den. In the last pass of the boiler he found 7 per cent CO_2. He then went after the first pass and found that the percentage there varied between 9 and 10. This being too low for his satisfaction, he made a careful examination of the firebox and found that one of the firebox doors closed tight at the top, but was open about five-eighths of an inch all along the bottom. This was due to the fact that the boiler columns had been thrown out of line by exposure to heat.

He could not shut down the boiler and the job was too hot to tackle at once, so he had the fireman plug the crack under the door with a piece of one-inch asbestos rope that was kept on hand for packing tube headers. As soon as this was done, the draft over the fire immediately jumped from ten- up to twenty-hundredths of an inch. After using the damper control to bring this back again to ten-hundredths, the CO_2 went to 10 per cent.

The boiler was one of a pair with a common dividing wall, so Smith and his helpers went after the firebox in the next boiler with lighted candles. A large number of leaks were found, so one of the men was sent in to plaster up the wall with a heavy coating of fireclay. Thereupon the CO_2 over the first pass immediately jumped to 14.5 per cent. However, it was still only 10.5 per cent in the second pass. Although the brickwork was coated with a leak-preventing mixture, Smith inspected it carefully, and was able to detect and plaster up a few small cracks, bringing the CO_2 in the second pass to 11.5 per cent.

The fact that this increase was so small showed that the trouble lay elsewhere. Smith and his assistants then went into the second pass of the dead boiler, and found the wall cracked right through. Pending arrival of a competent boiler mason, some fireclay was slapped onto this crack with the result that the CO_2 in the second pass rose to 14 per cent. The third pass was tackled in a similar manner but was found to be in good shape.

Having saved the situation for the time being by these energetic measures, Smith put in a hurry call to the nearest city in which a real boiler mason could be obtained, deciding that he would not get caught the same way a second time.

How Motion Pictures Were Taken of Burning Coal

The readers of *Power* may be interested to learn how Mr. Riley and Mr. Daniels were able to take the motion pictures of stoker operation which were exhibited at the recent annual meeting of the A. S. M. E. The main difficulty was, of course, the intense heat. After many experiments, this was finally solved as follows: The camera was mounted on a stand arranged to roll up to the door. A heavy asbestos shield over the front of the camera was made to fit more or less accurately in place of the door, while a similar shield at the side served to protect the camera from the hot brick lining of the door, when the latter swung open. This arrangement made it possible to run the camera up into position as soon as the door was opened, and maintain the same conditions as when the door was shut. As an additional precaution an electric fan was played on the camera and the operator.

The most difficult thing was to protect the camera lens from being broken by the heat. This was done by placing between it and the fire two sheets of heat-resisting glass, with a layer of gold leaf between them. The gold acted as a mirror and threw back into the furnace approximately 75 per cent of the radiant heat, while it allowed approximately 75 per cent of the light rays to pass through. This protector for the lens was itself cooled by two jets of compressed air, supplied at 100 lb. pressure. In order that the various colors in the fire might photograph in their correct relative intensities, it was necessay to use a special color filter, together with a film sensitive to all the spectrum colors including red.

Autogenous Welding of Refrigerating Equipment

By J. C. MORAN

THE rapid development of autogenous welding, oxy-acetylene, electric and thermit, in the manufacture and construction of refrigerating equipment is but little realized by the average refrigerating-plant operator. Nor are its possibilities, in the matter of improved pipe connections, facility in making alterations to existing equipment and piping, and the ease with which some of the most impossible repairs can be made, fully appreciated.

Like every other new development, however, autogenous welding still leaves a lot to be desired. The success of an autogenous weld is too much dependent upon the personal equation to be accepted generally as the most satisfactory method of joining metal parts together under all conditions. With improved instruments and apparatus, greater experience, and more data from research work, the time may come when practically all work of this nature will be welded.

There is generally little fault to find with the work done in the shops of manufacturers of established reputation. These concerns have men thoroughly trained to do this work regularly the whole year around, often handling one particular class of work exclusively for days at a time; as a consequence the grade of work turned out by such an organization should not be classed with that turned out by welders who take any kind of job that comes along.

Many welders urge welding for everything, even though they may not be thoroughly trained in this

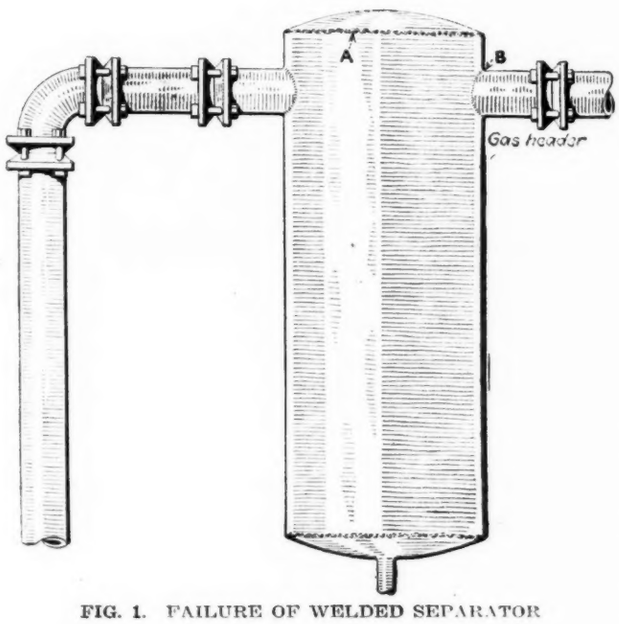


FIG. 1. FAILURE OF WELDED SEPARATOR

type of welding. An unusual expansion strain or a jar will often disclose a weak part in the weld, and soon the engineer begins to smell ammonia around the place. After the leak has been located by means of a sulphur stick, it necessary to plug it if the engineer has nerve enough to take a chance on continuing the defective part in operation. There is always a chance that the rest of the joint is as bad as the part that shows distress, and the prospect of having the whole joint blow off is not conducive to anyone's peace of mind.

A case of this kind came to my attention a few weeks ago. An oil separator for the discharge line of an ammonia system had been made by welding a flanged head on each end of a short section of 10-in. pipe. Fig. 1 shows the general construction of the separator and

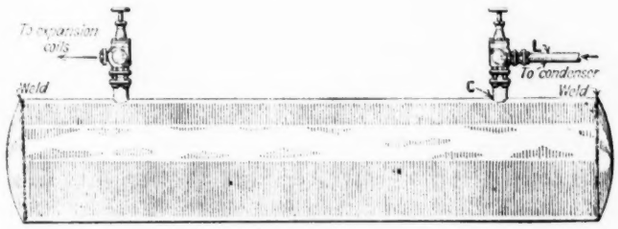


FIG. 2. WELDED RECEIVER FAILS

the location of the welds. The discharge line was anchored in such a way that it was quite rigid, and there was considerable strain on the separator whenever there was change in temperature. Every time the line expanded, the separator was flattened a slight amount, and when the line contracted the separator was strained in the opposite direction. The alternate expansion and contraction thus experienced a breathing action.

While this stress probably was not serious enough to cause any trouble in a screwed or riveted joint, the welded joint at the top of the separator, at the point indicated by *A* started to leak one day. Having had a few experiences of this nature before, I had the separator removed at once and replaced by a short section of pipe. All openings in the separator were blanked, being filled with water, and we proceeded to put a hydraulic test on it. When the gage registered nearly 400 lb., the weld at one end opened up for nearly half the length of the separator, and we found that a good joint had been made only at the outside surface. In other words, the joint had not been made sound clear to the bottom of the weld and only a thin sheet of metal was holding it.

In another case an ammonia leak was noticed around the plant, and after investigation it was finally discovered in one of the oil separators at the point marked *B* in Fig. 1. This separator was located very close to the gas header of the condenser, while the discharge pipe came up from the engine room below, the condenser being on the roof, and this pipe was about 50 ft. long.

Naturally, with the expansion and contraction of the discharge pipe, with one end of the horizontal section fastened solid to the gas header, there was a severe tendency to break the joints where the discharge-line connections were welded to the side of the separator, as indicated by *B* for the one side.

When the separator was removed, the whole joint was opened up with a few sharp blows with a hammer. In this case most of the metal had evidently flowed into the weld without fusing with the original metal except in spots, and the continual bending stress on the joint had broken open what little adhesion existed between

the original metal and the metal in the weld. This defect started the leak that led to the detection of the trouble.

In another case the trouble developed on a liquid receiver. Referring to Fig. 2, the liquid line *L* has a horizontal run of about 60 ft. from the condenser to the liquid receiver. We had occasion to blow hot gas through this line when cleaning some expansion coils by the hot-gas method. Suddenly, an explosion occurred at the receiver, and we had to rush out of the engine room and shut off the liquid connections at the condenser and the coils.

It was found that the liquid line connection at *C* had broken clean open in the weld. Evidently, the pipe had been sprung into place when being connected up, and the additional strain caused by the expansion of the line when the hot gas was shot through it had broken open the weld. In this case there were also signs of the metal not being properly fused together, but not so bad as in the cases that were previously mentioned.

In all these instances the apparatus had been made by concerns that had only recently started in business and did not have sufficient experience. With equipment made by the leading manufacturers of refrigerating equipment, I have never found any cause for complaint.

Welding Precautions

When it comes to performing a welding operation on the job and picking up anyone who calls himself a welder for the job, it is an entirely different matter. Unless I am firmly convinced that the man knows his business and has a good record to back him up, I prefer the regulation flanged and bolted joint to taking a chance with a weld.

One of the important points in doing welding with oxyacetylene method is to bevel properly the edges that are to be welded. If the two edges to be joined are beveled to an angle of 45 deg., the bottom parts of the joint can be brought quite closely together, but if the bevel is less, they must be held farther apart, becoming considerably greater when the edges are square. The distance must also be increased if the metal is thicker, and vice versa.

Probably in providing for expansion and contraction due to the alternate heating and cooling of the various sections of the weld as the work progresses, the difference between a man who knows his business and the amateur is most apparent. If a longitudinal seam is to be welded, a man that knows his business will place wedges along the joint or a screwjack at the opposite end from which the weld is started, and as the work progresses the wedges are removed and the jack slightly released at regular intervals, so that when the other end is approached the contraction of the weld already finished will practically pull the two sections to be welded into position. If this is not done the edges will close up at the end opposite from which the weld is started by the time the welding is half completed.

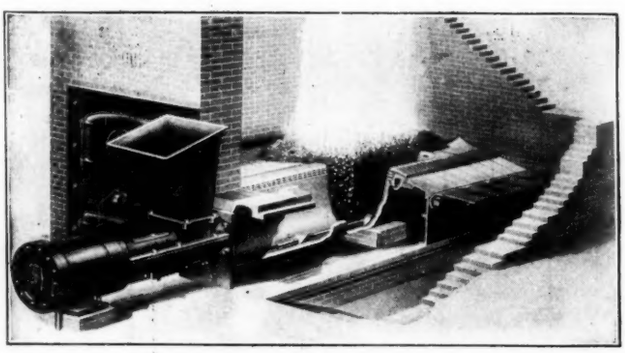
The same also holds good in welding branch lines to large mains or branch connections to headers. If proper provision is not made for expansion and contraction, the nipples when welded in will not stand out square, and if a long header is made up in this manner, it will become bowed, the contraction on the side on which the welding is done tending to curve the ends inward on this side.

The manner in which the torch is handled has also a good deal to do with the soundness of the weld. A certain combination of movement of the welding rod and the torch is absolutely necessary for good work. Some men perform most of the manipulation with the torch, while others secure the same results with an active puddling with the welding rod. In either case the idea is to distribute the heat evenly on each side of the joint, breaking down the edges and securing thorough penetration and union of the added material and the original metal.

The character of the welding flame is another important consideration, different types of flames being used for different classes of metals. For steel, what is known as the neutral flame is the best. In this flame the oxygen and acetylene just about neutralize each other, so that there is no action on the metal. If there is an excess of oxygen, known as the oxydizing flame, this produces a cutting action and attacks the metal. If there is an excess of acetylene, a carbonizing flame will be produced and this will tend to carbonize the steel in the weld, increasing its hardness and making it more brittle, neither of which is desirable, often resulting in a weak joint.

Jones Standard Side-Dump Stoker

A self-cleaning stoker of the side-dump type is the latest product of the Under-Feed Stoker Company of America. It differs from the Jones "Standard" stoker in that sloping combustion grates are used instead of the hand-cleaned dead plates, and a hand-operated dump plate on either side is provided for dropping the ash into the ashpit (see illustration). Depending on local conditions, the ashpits extend only 6 to 18 in. below



SECTIONAL VIEW SHOWING CONSTRUCTION OF SIDE-DUMP STOKER

the floor line, so that installation under new or established boilers is comparatively simple.

A correct ratio of air and fuel is maintained in the usual way. Preference is given to steam drive, but where the steam pressures carried are low, mechanical drive may be substituted. Where mechanical drive is used for several stokers, the various rams may be driven from a lineshaft operated by one motor or individual motors can be placed on each stoker.

To transform an existing Jones "Standard" stoker into a sidedump stoker involves a change in the tuyeres, the replacement of the dead plates with combustion grates and the addition of the dump plates. Excavation for the ashpits and a little brickwork complete the requirements.

EDITORIALS

Scope of Engineers' License Laws

THE great amount of discussion that has been heard recently about engineers' license laws, and the fact that such legislation has been passed in a number of states, has brought about a misunderstanding on the part of many engineers as to whether the new laws apply to them.

There are two kinds of so-called engineers' license laws. One affects operating engineers, men who have charge of power plants or who run power-producing machinery. The other is entirely different in that it affects professional engineers, particularly civil engineers and surveyors. One or the other of these classes of legislation is to be found in many of the states, and in some cases both kinds exist.

Before beginning to worry about obtaining a license, an engineer should find out whether the law in his state applies to professional or operating men. By so doing, he will save himself and the government officials a great deal of needless effort. Owing to the recent enactment of an engineers' license law in New York State, the Department of Labor at Albany is receiving numerous requests for information from stationary engineers who believe that the new law applies to them.

Incidentally, this is just another example of the inevitable confusion arising from using the one word "engineer" to cover all branches of work pertaining to engineering whether of an operating or a professional character. It is to be hoped that eventually some new term or terms will be agreed upon in the interest of convenience and accurate thinking.

Tendency Is Toward Standard Voltages

MOST of us have become so accustomed to a few of the more common voltages used for industrial-power circuits that we have acquired a sense of feeling that motor voltages have become standardized. However, there still exist some rough spots as shown by a recent industrial survey of the State of Pennsylvania made by *Power* and the *Electrical World*. This survey shows that there are in use seventeen different voltages for the operation of direct-current motors and twenty-one for alternating-current motors. Although there is a wide range of voltages in use, an analysis will show a decided tendency toward the use of a few that are becoming standard.

Of three hundred and eighty companies in various industries, three hundred and thirty are operating at only six different direct-current voltages. This leaves eleven different voltages confined to fifty companies. The voltage used by sixteen of the latter companies might have been included in those of the former, since the difference amounts to only five or ten volts. This indicates that even if standard voltages have not been adopted in general, there is a tendency in that direction for direct-current machinery. In the use of alternating-current motors the tendency toward standard voltage is even more marked. Out of six hundred and nineteen companies reporting in the various industries, five hundred and eighty-six use six different voltages. Therefore the remaining fifteen voltages are distributed among thirty-three different companies. If the motors are grouped according to the voltage that it is possible to operate them at and keep within the manufacturer's guarantee of ten per cent voltage variation above or below normal, all but six of the companies using alternating-current motors fall within the range of five voltages; namely, one hundred and ten, two hundred and twenty, four hundred and forty, five hundred and fifty and twenty-two-hundred volts. Even though we have not arrived at complete standardization of motor voltages, the tendency is decidedly in that direction.

Where motors are supplied from the end of a feeder, unless some means are provided to compensate for the pressure drop in the line, the voltage at the motor may be almost any value from that at the generator or transformer to ten per cent, or even more in some cases, below this value. Therefore there can be little excuse for adopting voltage ranges in increments of five and ten volts on one-hundred and ten and two-hundred and twenty volt motors since after the motors are installed they probably will seldom be operated within five or ten per cent of the normal voltage. If we consider the facts as they really are in practice and not in theory, it will do much toward eliminating a number of the apparent inconsistencies in motor voltage.

Making Power Subsidize Fertilizer

ONE of the three proposals now before the Secretary of War for the development of the Muscle Shoals power and nitrate plants is that made by F. E. Engstrum. It is one of the proposals of which the Secretary is reported as saying, "It is much less satisfactory than the offer by Mr. Ford." Nevertheless it has an important bearing upon this big project.

Mr. Engstrum proposes to organize a corporation in which the Government will be represented by two of seven directors, to complete and to operate the Wilson Dam, Dam No. 3 and the nitrate plants. The expense of completing the construction on the two dams would be paid to this company through appropriation by the Government of $36,000,000, payable to the corporation in four annual installments during the four years within which construction is to be completed.

As much power as is needed for the purpose is to be supplied from the dams for operation of the nitrate plants—this without any charge to the nitrate operations. It is further proposed that these plants be operated with the benefit also of that part of the income from the sale of surplus power above that amount which is necessary to pay for operation and repairs of the power plant, up to a total of one mill per kilowatt-hour.

Mr. Engstrum's company would get as compensation for the construction work and for the operation of the

properties, the reimbursement of $36,000,000 and "all proceeds from the sale of power in excess of one mill per kilowatt-hour." If the company is asked to build or operate the locks and care for matters of navigation, the actual cost of this will be paid to the company by the Government, except that the Government would receive without charge a predetermined amount of current for the operation of the locks.

The surplus power from the dam above that necessary to operate the nitrate plants and the locks would be sold. This power would come primarily from what is known as "secondary power," or that which is developed by storage of water and operation above the minimum capacity at periods of low water during an ordinary season. Substantially all of the "primary power" would be needed for the nitrate plant and locks. As previously indicated, none of this surplus would be sold at less than one mill per kilowatt-hour and the Government would be entitled to one mill per kilowatt-hour on whatever was sold irrespective of the price. So much of this mill as is not needed for operating expenses at the power plant will be used to pay any deficit incurred in operating the nitrate plant, with the free power. If there be anything left after paying such deficit, the balance goes to the Federal Treasury.

The income above one mill per kilowatt-hour from the sale of the surplus power is to go to Mr. Engstrum's company as a return for services rendered. It is roughly estimated that the surplus may be sufficient to make about one million dollars per year income for Mr. Engstrum for each mill per kilowatt-hour above the first one mill. In other words, if two mills can be obtained for the power thus sold, Mr. Engstrum's company would have one million dollars per year profit in payment for services and for the promise to risk a possible additional investment of about five million dollars. Or if the sale should be so favorable as to return three mills per kilowatt-hour, there would be two million dollars per year for these gentlemen.

Whatever one may think of Mr. Ford's offer, it does not take long study of the foregoing facts to understand why the Secretary of War announces that Mr. Engstrum's proposals are less acceptable.

Does Firebrick Limit Combustion Progress?

THE statement has been made repeatedly that no further advances in boiler capacity and efficiency could be made without corresponding advances in refractories. Now this idea is being vigorously contested by the makers of firebrick.

Not so many years ago it was generally assumed that a boiler evaporating three pounds of water per hour per square foot of heating surface was doing well. Then came the realization that this was mere loafing compared with what a boiler could do. Stokers and mechanical draft came into general use; settings were raised; coal was burned with a minimum of air.

This brought capacity and efficiency, but along with them came furnace troubles. The conditions were cruel for firebrick. Broad expanses of refractory walls and arches were subjected to a combination of intense heat and the scouring action of gas currents. Furnace failures were frequent and expensive.

Experience brought improvement, but there seemed to be a certain limit of temperature and capacity beyond which the increased expense due to furnace deterioration canceled any further saving in fuel and initial investment. The furnace designers and practical operating men had reached the point where they said to the makers of firebrick: "We have gone the limit with the refractories now available; the next step is up to you!"

But the worm has turned. The makers of firebrick refuse to take the blame for rapid furnace deterioration. Refractories, they say, have kept pace with the art of combustion; the trouble is due to the users who have not properly selected or used the available materials. They point out that improper furnace design subjects the firebrick to excessive pressure, that certain mortars eat out the brick at high temperatures, that joints are ordinarily much too thick, and that operating abuses, such as sudden chilling, are common.

Whether or not these contentions are wholly or in part true, it is well to recognize that the subject is one of great practical importance. If it is required only to educate the users of firebrick, they will doubtless take any necessary instructions in good part and proceed to mend their ways.

Power-Plant Efficiency

IT IS usual to ascribe the lower power generating costs of the central station compared to those existing in the average isolated plant to the more efficient machinery. Unquestionably, the large steam-turbine plant is inherently more efficient than the prime movers in the smaller plants, but another factor in the results secured is the presence of trained engineers and proper operating procedure.

On page 139 appears a discussion of boiler-room operation as followed in one of the large central stations. As the author points out, the men are hired on the basis of intelligence and are promoted step by step as they become more proficient. In addition they receive instructions in the rudiments of boiler-room engineering. This is in striking contrast to many small plants, where the fireman's ability is based on the strength of his arms and back without regard to how little or how much he knows of the process of combustion. Moreover by the aid of a schedule, the machinery is maintained constantly in a state of good repair. Contrast this with the plants where a machine is never adjusted until something breaks.

Engineers will find much food for thought in this discussion of boiler-room operation. If the individual plant is to hold its own, similar systems must be adopted. It is not difficult to secure intelligent firemen if the pay is made attractive and the boiler room kept one-half as clean as is the engine room. A schedule can easily be arranged without any great amount of red tape. Such an arrangement will provide for an inspection of each machine at stated intervals.

One-thousandth of a pound supported on one-millionth of a square inch is equivalent to a pressure of one thousand pounds per square inch. If all those who have to handle and install electrical instruments will keep this fact in mind, it will help to understand why instruments should not be subjected to rough handling or vibration. The bearing pressure between the pivots on the moving element and jewels may amount to over one thousand pounds per square inch in some of the best instruments, which reminds us that it is not alone the weight suspended that must be considered, but also the area on which it is supported.

PRACTICAL IDEAS from PRACTICAL MEN

How Should Piston Rings Be Machined?

I would appreciate the opinions of readers of *Power* regarding the most satisfactory method of machining piston snap rings to fit steam-engine cylinders.

We use snap rings up to 66 in. diameter, mainly in the neighborhood of 40 and 66 in. diameters. A step-cut lap joint is used. The radial thickness of the 40 and 66 in. rings is usually 1½ and 1⅝ in. and the width 1¼ and 1½ in. respectively.

The rings are carefully calculated for stress and radial pressure by a method outlined by a German designer. They are cut from a pot after rough turning and boring and then the step-cut lap is machined with 2 and 6¾ in. respectively, cut out to allow for compression and clearance when in place. They are then compressed to the cylinder diameter plus the allowance for the finish turning and are finish turned to the cylinder diameter and finish bored.

A question arises regarding the method of compressing the ring in this last operation. Some maintain that the ring will have a more uniform pressure if pulled together at the step-cut joint and drilled and pinned to a mean diameter equal to the cylinder diameter plus the finish. Others hold that they should be sprung into a jig bored to the cylinder diameter plus the finish. It is upon this point that I would like to have the ideas of readers of *Power*.

J. T. REA.

Bethlehem, Pa.

Waste of Steam at Safety Valves

I have had many safety valves practically ruined by excessive blowing, which caused the seat and disc to become grooved and cut with the resultant leakage which, as it continued, further wore away the disc and seat and thus increased the volume of steam leakage.

When the flue damper is controlled by a damper regulator, the regulator should not be set at a pressure too close to the blowing pressure of the safety valve, as in most cases the dampers will allow from one to three pounds increase in pressure while closing, and frequently, if the damper is sluggish, the pressure will rise five pounds before the damper closes sufficiently to check the fire. Then also, when carrying heavy fires, it is necessary to have the flue damper open more when in the closed position than when carrying lighter fires, to allow the gases to escape into the stack instead of into the boiler room. If the damper opening is in excess of that required to prevent smoking at the furnace and hood doors when in its closed position, the pressure will run up and a sudden lessening of the load on the engine will cause the safety valve to pop. It is the general custom in this vicinity to set the damper to close at about ten to fifteen pounds below the blowing point of the safety valve—ten pounds less if the damper closes fairly tight, and fifteen pounds less if it has to be left partly open to carry off the gases from a heavy fire. The fire will therefore be checked and the damper closed when the steam pressure is at least five pounds less than blowing-off pressure of the safety valve. The lower the running pressure the less probability of the safety valve leaking and the less chance of the seat and disc being grooved and cut.

In some plants the boilers are not capable of carrying the full pressure needed in operation and it is necessary to carry a running pressure, without frequent blowing of the safety valves, as close as five pounds, which would keep the pressure close to the blowing-off point. Most firemen will carry the steam at a point that will cause the safety valve to blow with slight load changes.

There is a tendency among firemen to push the fire when the load is coming on, but this should be done only in proportion to the rate of feed water fed to the boiler and the rate of steam flow from the boiler. That is, if the demand for steam is for a short period and the water is at high level in the glass, the pump should not be speeded up until the water in the boiler has dropped to a lower but still safe level, and then only enough water is fed to the boiler to maintain that lower level while the heavy demand for steam continues, and maintain only enough fire to keep up the steam pressure for the increased demand. When the demand for steam decreases and the damper closes, the feed pump can be speeded up and extra water pumped into the boiler to raise the water level up to about the second gage again. This will generally hold the steam pressure down while the fire is being checked.

In some cases it is good policy to slow down the feed pump for a few minutes, when there is plenty of water in the boiler, to hold up the steam pressure while forcing the fires, and speed up the pump while checking them to maintain an even steam pressure without the safety valve blowing.

R. A. CULTRA.

Cambridge, Mass.

Keeping Motor in Service When Field Coil Is Grounded

Fig. 1 shows a 4-pole shunt-wound motor connected across a 600-volt street-railway line with a ground return. The single-pole switch connects to the trolley wire, and the motor frame is grounded with one armature lead and one field lead connected directly to the frame to form the ground-return circuit. Coil S_1 of this motor, which was engaged in important work, became grounded. This caused a short-circuit which not only blew the fuse, but also damaged the coil to some extent, but the ground remained. This ground on coil S_1 left a short-circuit on the motor and cut all the field coils out of circuit. It was urgent that motor service be maintained with minimum delay, and owing to the location of the machine, to have removed the field coil for repair would have required several hours. Accordingly, the expedient indicated by Fig. 2 was adopted. The field leads were crossed, which placed the grounded field coil next to the ground connection on the motor frame, where the fault could not affect operation. Crossing the field connection reversed the direction of the current through all coils, and this would have reversed the direction of rotation of the armature. To give the armature the correct direction of rotation, the brush leads were interchanged as indicated in the figure, before starting the motor. This scheme is applicable irrespective of the location of the faulty field coil in the field circuit, provided the precaution is taken to check the polarity of all polepieces after the change is made. For example, assume that the ground was on coil S_3, Fig. 1. In this case remove the connection between S_2 and S_3, disconnect the ground lead from F_2 and connect it to F_3 on coil S_3. Also disconnect the lead from F_1 and connect it to coil S_2 and connect F_1 and F_2 together. This connects the grounded field coil directly to the ground terminal on the frame, but reverses the current through the field coils, consequently the armature lead will have to be reversed to maintain correct direction of rotation. Furthermore, in the case of a compound-wound motor it would be necessary to make in the series-field connections such changes as would give the two field windings the same polarity.

E. C. PARHAM.
Brooklyn, N. Y.

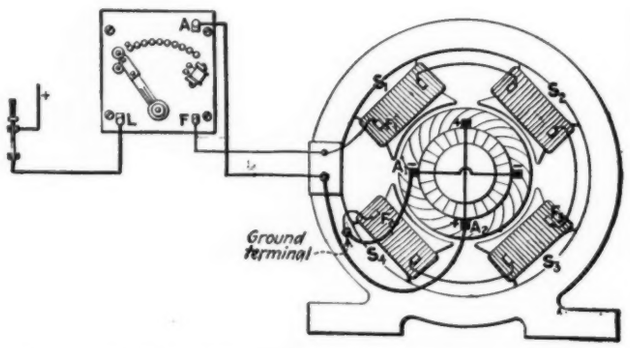


FIG. 1. CONNECTIONS BEFORE CHANGE WAS MADE TO OPERATE SHUNT MOTOR WITH GROUND IN FIELD COIL

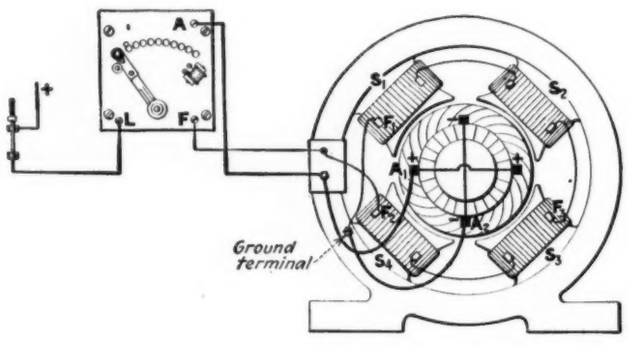
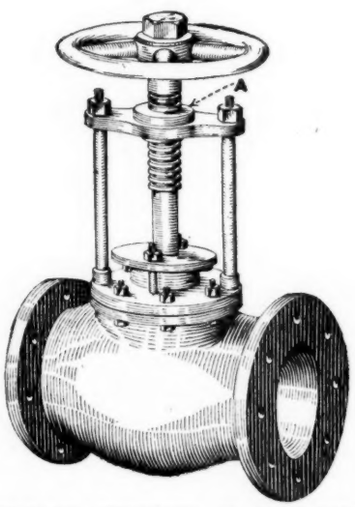


FIG. 2. SAME AS FIG. 1, WITH FIELD AND ARMATURE CONNECTION CROSSED

Repair to Steam Stop Valve

The illustration represents a steam stop valve that was fitted to the steam main of a Lancashire boiler. The valve gave trouble one morning when the brass valve-stem nut in the cross-bar, stripped its thread. This rendered the valve practically useless as it was kept off its seat by the pressure from the boiler, with a consequent wastage of steam in the long pipe line between the boiler and the next stop valve. A new brass nut was ordered from an engineer ten miles distant, but it was found upon assembling the new nut on the spindle that an error of measurement had been made by the workman, the nut being too large in diameter over the bottom of the threads. Considerable money for such a small job had thus been unnecessarily thrown away.



THREADS STRIPPED IN THE NUT A

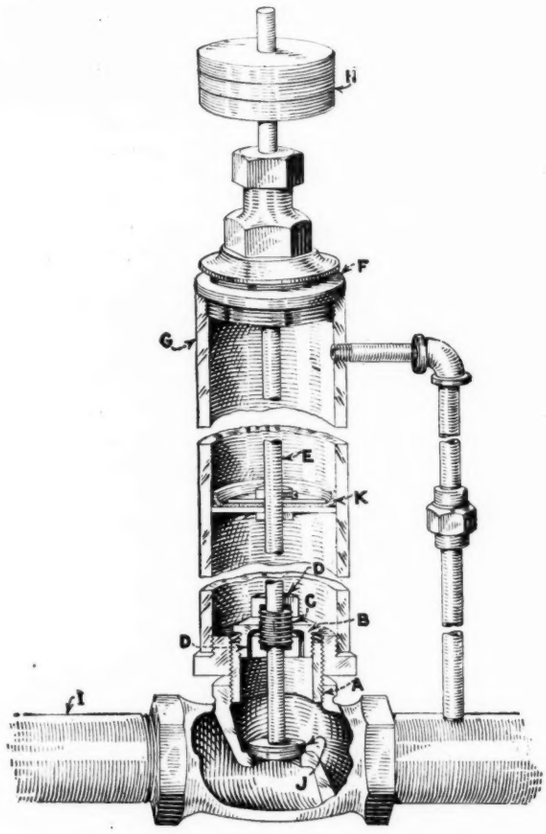
An assistant casually mentioned that the little foundry up the street often cast brass nuts on screwed spindles. The steel screwed spindle, together with the old brass nut, was sent to the foundry.

A wood block about the diameter of the nut was placed on the spindle and both were placed in a molding box and then removed. The spindle was withdrawn from the wood pattern and coated with plumbago. After being slightly heated, it was again placed in the mold and brass poured in, filling in the space around the screw left by the pattern. A little trimming up on the lathe completed the job, and the valve was in commission again in a few hours.

FRANK BRADSHAW.
Eadington, Eng.

Small Home-Made Regulating Valve

It is doubtful if anyone will claim that a home-made device is as good as the manufactured article, but many of us cannot purchase all of the equipment that is desirable, and in many instances necessary. In one case



DETAILS OF REGULATING VALVE

a steam-regulating valve was needed, and as none was forthcoming, one was made about as shown by the illustration.

The body of a 1¼-in. globe valve was secured and the top opening was threaded for a 1¼-in. close nipple *A*, which was tapped at the top on the inside for a 1 x ⅜-in. bushing *B*, into which was screwed a ⅜-in. close nipple *C*, fitted at each end with a ⅜-in. cap, each cap being drilled centrally for a ¼-in. rod *E*. These caps were for stuffing boxes.

On the outside of the nipple *A* a 1¼ x 1½-in. bushing was screwed to carry a piece of 2-in. pipe about 6 in. long, threaded on the inside at each end for a 1½-in. pipe. The top end was fitted with a 1½ x 1-in. bushing *F*, into which was screwed the top of a valve to serve as a stuffing box for the stem *E*.

A brass disk was used for the valve and was tapped for screwing on the bottom end of the valve stem. About halfway in the 2-in. pipe *G*, and freely fitting, is a brass disk that is secured to the rod *E*, and on top of it is a rubber cup washer *K* to make a steamtight packing, a brass washer and a holding collar. The upper end of the rod is fitted with a weight *H*, and a 1¼-in. pipe connection is made between the low-pressure discharge pipe and the upper part of the 2-in. pipe.

The weight *H* is increased or reduced so as to counterbalance the high-pressure steam coming in at the inlet *I*, which comes in under the disk *J*. By properly balancing the area of the disk *J* and the cup piston *K* and adjusting the weights *H*, the design of the valve can be made to work with almost any difference in pressure desired.

C. A. HALL.

Denver, Col.

Why the Radiators Would Not Heat

There will be no harmony in a central steam-heating plant until some simple metering device can be placed on each radiator or group of radiators to each tenant, and the amount of steam used paid for each month, as they would pay for gas or electricity. With such an arrangement consumers would use no more steam than needed. There is no doubt that a vacuum system is the best, when properly installed and good vacuum traps are placed on the returns.

The illustration shows one of the heating lines installed last fall in a five-story office building. It worked well at the try-out, the steamfitter was proud of the job, and everybody interested was satisfied. As time went on, the tenants on this line complained of no heat. The steamfitter would remove the cap from the vacuum trap at the heel of the riser, and say there was dirt in the trap and when steam was turned on the radiator would heat up. This was repeated several times.

One day the tenants complained of no heat all the afternoon, and every radiator was found to be cold. In the boiler room the fireman had 1 lb. pressure and 8 in. of vacuum in the line. Upon removing the caps from the vacuum traps of several radiators, there was

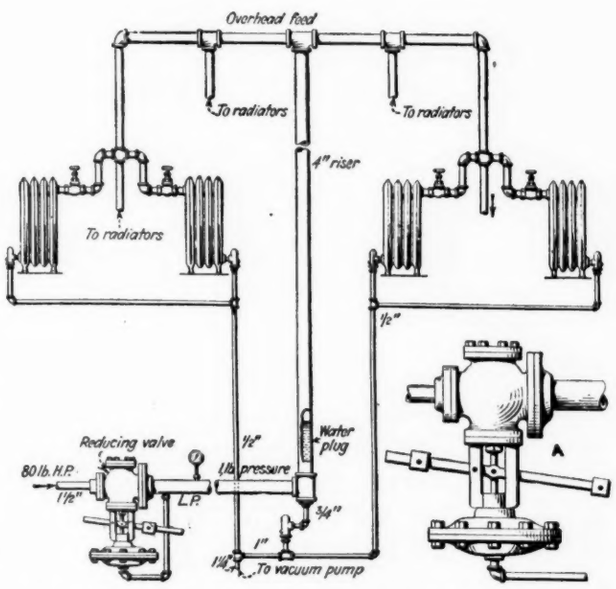


FIG. 1. ONE OF THE HEATING LINES AS INSTALLED

found a good vacuum but no steam. The steam pressure was increased to 5 lb. and the vacuum to 15 in., and still the radiators remained cold. Steam was shut off for about three minutes and turned on again, and in a jiffy every radiator on the line was hot.

As a matter of fact water had collected in the heel of the 4-in. main riser and acted as a valve on the line. When the steam was shut off, the water dropped back

through the vacuum trap to the pump, thus clearing the line, and allowed steam to pass through.

With the weight on the lever of the reducing valve, as shown, when steam was turned on the system the gage on the low-pressure side would show 4 lb. pressure. It would decrease gradually, and after about three hours would be at atmospheric pressure and would

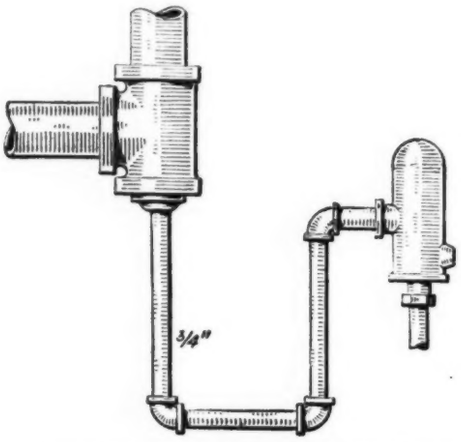


FIG. 2. PIPING THAT ONE STEAMFITTER USES

stay there. After the weights were placed on the lever as shown at *A*, any desired pressure could be constantly maintained.

There are few vacuum systems that are not troubled with leaky vacuum traps, which keep the return at a high temperature. I have tried two buildings that had the same amount of radiation and each had a condensation meter on the returns. After the buildings were warm, the valve in the return of one building was choked down so as to pass enough condensation to keep the temperature of the returns low. The other building was allowed to run under normal conditions. Both were controlled with one reducing valve on the steam inlet. The building with the choked return valve would use about 25 per cent less steam than the other.

A steamfitter that I know, who makes vacuum systems a specialty, puts a loop, as shown in Fig. 2, on the mains and risers and swears by it. No doubt it has its good points, but with the system in operation there will be no condensation found in the loop, as a vacuum trap will remain open just enough to keep the water of condensation removed. THOMAS SHEEHAN

Springfield, Mass.

Simultaneous Regulation of Forced and Natural Draft

Recently, an interesting application of a CO_2 recorder was made in a plant equipped with return-tubular boilers and underfeed stokers which were naturally of a small size, the draft being furnished by a fan driven by a direct-connected steam engine. The speed of this engine is controlled by an automatic regulator governed by the steam pressure.

The load on the plant is variable, running up to considerable peaks for a time and then dropping off. This results in frequent slowing down of the fan so that the engine will just pass the center without stopping. Under these conditions the CO_2 record was irregular, ranging from 4 up to 13 per cent, although the fire was in a good uniform condition, in marked contrast with the appearance of the record, which could be taken to indicate a bad firing condition. The low points of CO_2 came when the fan was slowed down; in other words, when the air supply was practically cut off. Under such conditions a lowering of CO_2 could be attributed to incomplete combustion in which carbon would go to CO instead of CO_2. An investigation of the matter disclosed the cause of the trouble and led to its correction.

Fig. 1 shows the location of the sampling pipe as installed, taking the gas sample from just below the damper. The plant is served by quite a high chimney, so that the natural draft in itself is strong. As there was no indication of incomplete combustion, it was concluded that when the fan was down, the natural draft caused a sufficient leakage of air through the joints of the boiler front to dilute the gas sample. To cure this, the sampling pipe was changed, as shown in Fig. 2, with the idea of avoiding the air current. The result was a decided improvement in the CO_2 record, but not enough to justify expectations.

One boiler was then selected for experiment, and the uptake damper was so manipulated as to maintain a practically uniform draft over the fire, irrespective of the speed of the fan. The result was an excellent CO_2 record averaging 15 per cent and running quite uniform. The reason for this later improvement was that when the fan was down, the strong chimney draft caused sufficient air leakage into the furnace so as to dilute the gas a serious amount, and when this was corrected by checking the damper, all was well. To make this result automatic, the function of the fan regulator was extended to control the chimney draft as well as that of the fan, so when the fan speed is reduced, chimney draft is reduced as well.

An interesting feature of this case is that the method of firing was not changed in any respect, although the

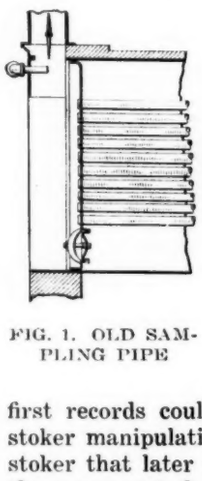


FIG. 1. OLD SAMPLING PIPE

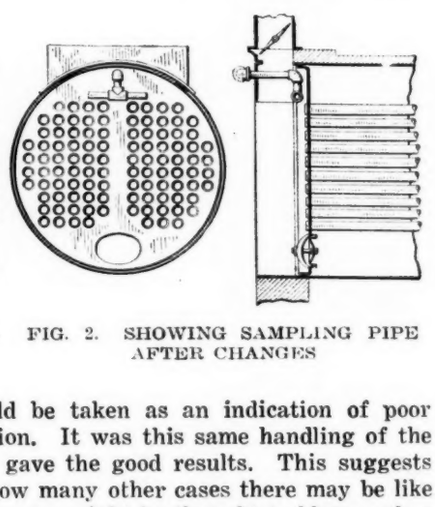


FIG. 2. SHOWING SAMPLING PIPE AFTER CHANGES

first records could be taken as an indication of poor stoker manipulation. It was this same handling of the stoker that later gave the good results. This suggests the query as to how many other cases there may be like this where the fireman might be thought to blame, when instead it may be a similar case of faulty draft regulation. A. BEMENT.

Chicago, Ill.

Unequal air gaps are responsible for much commutation trouble. If one pole face is nearer the armature, the flux across the gap is greater and a higher voltage will be developed in the coils under that pole. This may result in heavy short-circuit currents between the studs adjacent to that pole and other studs of the same polarity.

American Flue Cleaner

In reading the article on page 715 of *Power*, Nov. 8, 1921, describing the American flue cleaner, I found three errors of statement. Being the inventor of this device and desirous of doing myself and the device justice and not mislead the reader, I wish to point out the following:

The statement is made that all the tubes are blown at one time, when the fact is that only one vertical row of tubes is blown at once.

It is also stated that each row of tubes contains an automatic drip valve. This is incorrect. The automatic drip valves are placed on the drip pipes from the steam separators to prevent failure to drain the system through negligence when the steam is turned on the device. The valves for blowing each row of tubes are of different design and metal.

The statement is made that, due to the automatic drip valves, dry steam is secured, whereas it is due to the steam separator that dry steam is obtained.

Philadelphia, Pa. MARION R. BOWE.

Finds Co-operation Is Lacking

I read with interest J. M. Sullivan's article, "Co-operation," page 835 of the issue of Nov. 29, 1921, and from my observation I should say that it contains more truth than fiction. As a boiler inspector I visit many plants, and find remarkably few cases of co-operation between the boss and the engineer, and many leaks about the plants that could be stopped at small cost.

The waste of fuel caused by defective boiler settings probably cannot be estimated, but I believe that there are few boiler settings to be found without some preventable air leaks were they properly candled. I find that fuel waste is greater in power houses in mining districts, where coal is frequently valued as so much dirt by the firemen, as they can have all that is wanted to throw in the furnace and "no kick coming" so long as the mine is kept going. As a rule it is useless to make recommendations for the saving of coal at such plants, especially if it means the purchase of apparatus, such as a feed-water heater, etc. In one plant there has been a perfectly good heater lying outside the boiler room for four years, and during that time on my visits I have never failed to call the superintendent's attention to what could be saved were it installed. On one occasion I told him that if he would install the heater and could not save more than a ton of coal a day, I would pay for the installation.

Cases are not rare when, on going on top of return-tubular boilers, the shell is found to be uncovered and the cracks between the boiler and the walls on both sides so wide that the flames can be seen traveling to the rear. What this means in reduced efficiency can well be imagined.

A few years ago I visited a plant having five return-tubular boilers that had never had any previous inspection, and one was down with a bag. The furnace doors were practically useless. Half of one door was missing on one boiler and the others were so badly warped that they could not be closed. The combustion chambers were filled with ashes to within three inches of the boilers. They told me that if they cleaned them out, the cracks in the walls let in so much air that they were not able to keep up steam. My principal recommendations were to repair the boiler fronts and reset the boilers. After this was done, two boilers did more work than four as formerly fired and one man less was needed in the boiler room. Such conditions are the result of placing boilers in charge of ignorant or inexperienced men.

Another plant had four return-tubular boilers that were not giving the results they should. Certain recommendations were made for changes in the settings, but no attention was paid to them as the boilers were furnishing all the steam needed. Later on, after the load increased, efficiency engineers were engaged to see if the efficiency of the plant could be increased. The settings were changed as I had recommended, with the exception that the wide walls were closed in too low down on the boilers, which cut off 72 sq.ft. of heating surface on each unit. In this case the boiler inspector and the engineer were of the same mind, but the head office of this company was in a distant city and there was no co-operation between the engineer and the manager. JACK LUTHER.

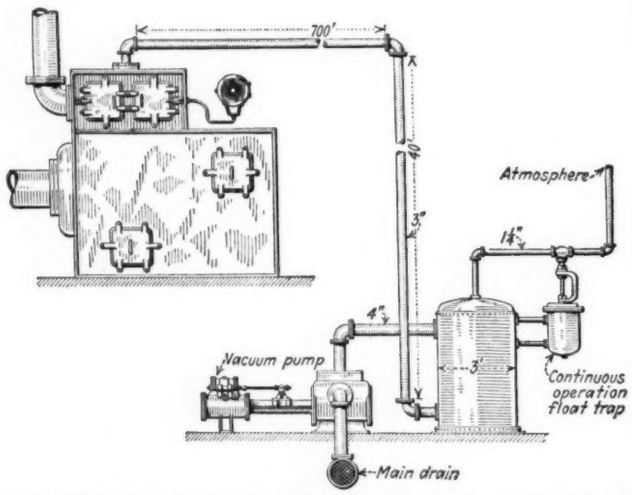
New York City.

Explosions in Open Feed-Water Heater

In reply to R. Miller's request for an explanation of the explosions in an open feed-water heater, page 984 of the Dec. 20, 1921, issue of *Power*, I submit the following:

The cause of the trouble was the failure of the air trap to keep the tank free from air. This may have been due to the trap sticking, or it may have been due to insufficient capacity. The result was that the tank filled with air, which would be under a maximum pressure equal to the back pressure in the heater, plus the weight of the 40-ft. column of water. When the air

reached the outlet near the bottom of the tank, it would begin to escape into the riser. This would reduce the weight of the water column, and the escape of air would be accelerated, with the result that the flow of water into the heater would be increased, which would in turn condense the steam, reducing the pressure there and still further accelerating the flow of air from the



MR. MILLER'S SKETCH SHOWING HEATER AND PIPING CONNECTIONS

tank. The mixture of air and water discharging into the heater would cause the splash and rattle.

When the pressures reached equilibrium, the water in the riser would flow back toward the tank, trapping the air there, and if the 700-ft. run were graded toward the riser, the water in the run might flow backward also, and there might be a slight water hammer at the heater end of the run. This water hammer may be the explosion to which Mr. Miller refers. He does not say whether "splash and rattle" and "explosion" mean the same thing. When the air pressure in the tank would again reach the back pressure in the heater, plus the weight of the water column, the process would be repeated.

I do not see how the check valve prevented the trouble. Mr. Miller does not say that it did. He merely says that the explosions ceased after putting in the check valve. There is room for a suspicion that the air trap was made to function properly, and so long as it did so there should be no trouble. If the 700-ft. run was graded back toward the riser, the installation of a check valve at the top of the riser, or in the run near the riser, would prevent a back flow of water from the run into the riser.

The sketch shows the diameter of the tank as 3 ft. If the sketch shows the relative height correctly, then Mr. Miller's return lines are leaky, if the explosions were taking place every few minutes. Sometimes these leaks are hard to locate. Our heating system was changed over in 1920 to a vacuum return. Previously, it had been connected with the city sewer system, all condensation going to the sewer. A dry kiln had previously been served with low-pressure steam, the condensation being removed by a vacuum pump and discharged to the sewer.

A 1-in. drain from one of the radiators had not been given room for expansion and it broke off. When we changed to a vacuum system, this break was unknown, but we did know that the vacuum pump had to travel fast. About three months ago I discovered evidence of a leak underground and had the pipe excavated and the 1-in. pipe was found broken. Now the vacuum pump travels less than one-quarter as fast as formerly. There is probably ten acres of floor area in the system, possibly more.

I would suggest that Mr. Miller chase leaks for awhile and note the results, but particularly I would like to have him tell us how close our explanations come to facts as he has found them.

R. McLAREN.

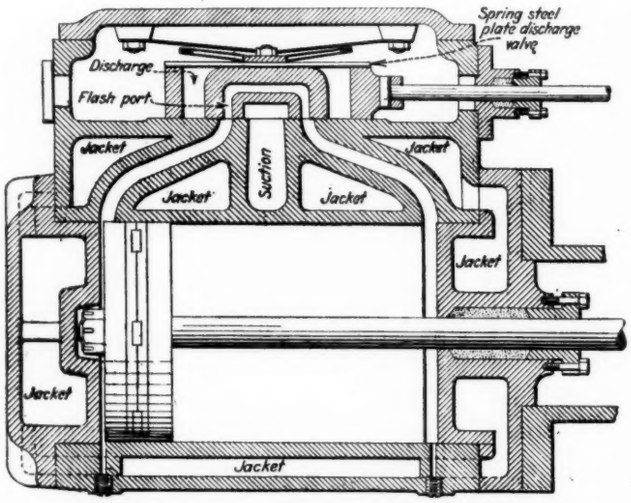
Toronto, Ont., Canada.

Permissible Air-Pump Clearance

In the Nov. 29, 1921, issue, page 863, C. N. F. asks in regard to reciprocating dry-air pumps used with condensers, how a small clearance in the air cylinder can be avoided without trouble arising from the expansion of air contained in the clearance space when the piston starts on its suction stroke.

The answer given states that the air compressed to atmospheric pressure in the clearance space has to expand down to condenser pressure on the suction stroke before there is any intake of air from the condenser, clearance in the dry-vacuum pump acting in the same way as in an air compressor to reduce the volumetric efficiency of the cylinder.

This is true for some types of machines, but several manufacturers build a dry-vacuum pump that has an equalizing or flash port in a slide or semi-rotative admission valve, arranged to connect the two ends of the cylinder at the completion of each stroke, after the closing of the suction port, thus practically eliminating the effect of clearance and preventing loss of efficiency, which would otherwise result from the re-expansion of



AIR-PUMP VALVE DESIGNED WITH FLASH PORTS

the vapors at the beginning of the suction stroke. By this means air in the clearance space at atmospheric pressure is allowed to flow back to the suction side of the piston, which is at condenser pressure, thus reducing the pressure in the clearance space to condenser pressure, allowing an immediate intake of vapors from the condenser on the suction stroke.

The sketch shows one type of valve fitted with a flash port. This slide valve is driven by an eccentric on the crankshaft, and has on the back of it a spring steel-

plate discharge valve that opens automatically when the discharge pressure rises to atmospheric pressure. Note that at the end of the stroke the flash port registers with the cylinder ports and that the suction is closed. Thus the air in the clearance space can go nowhere else but to the other side of the piston which has just completed its suction stroke for that side and is at the condenser pressure. The suction opening and closing and the discharge closing are all controlled by the main slide valve, the discharge opening only being automatic.

Another type accomplishing the same result has a semi-rotative positively actuated valve with a flash port through it, and has a poppet spring-loaded discharge valve, all valves and ports being below the cylinder to facilitate drainage. H. G. ROBERTS.

Richmond Highlands, Wash.

A Home-Made Electric Heater

In the Nov. 29 issue of *Power* there was a description of a home-made electric heater, or perhaps it would be better to say a suggestion for one, as it would appear to be very doubtful if a heater just as described has ever been in successful use. The heater is to be wound around a core made of a piece of 3-in. iron pipe 4 ft. long, and insulated from the bare wire of the winding by layers of sheet asbestos or asbestos paper. Nothing is said as to there being more than one layer of wire or of placing insulation between such layers, as would have to be done with the bare wire suggested for use, so that the description, at least, calls for only one layer of wire.

Standard-weight iron pipe having a nominal diameter of 3 in., has an actual outside diameter of $3\frac{1}{2}$ in. If the asbestos insulation were a quarter of an inch thick all around the pipe, that would add a half inch to the diameter of the whole, making 4 in. in all. The length of one turn of wire around the pipe and insulation would then be 4×3.1416 in., or slightly over $12\frac{1}{2}$ in. If the section of the wire was No. 10 B.w.g., a fair size for the kind of wire mentioned in the article, its diameter would be 134 mils, or there could not be more than seven turns of the wire per inch along the pipe, and it would be very hard to get in that number of turns per inch and yet not have any of the turns touching each other and therefore short-circuiting the resistance. The amount of wire wound on per inch of length of pipe could then be only 88 in., and as the distance between terminals is a maximum of 36 in., the greatest length of wire that could be wound on in one layer is 264 ft. or $\frac{1}{20}$ of a mile.

No. 10 iron or steel wire has a resistance of from 19 to 26 ohms per mile, depending on the composition of the metal. Allowing 26 ohms per mile, the maximum possible resistance, the resistance of the 264 ft. of wire wound on the pipe would be only $\frac{1}{20}$ of 26, or 1.3 ohms. Therefore the current would be almost 170 amp. on 220 volts, which would immediately blow the fuses, which are shown as being of only 30 amp. capacity.

With 110 volts across the switch and the resistance wire of the heater halved and the two halves placed in multiple, as shown in the picture as an alternative arrangement, the resistance of both circuits together would be only one-quarter of that which the wire would have when arranged for 220 volts, so that the current would amount to practically 340 amperes.

It may be that the writer of the article in question intended that several layers of wire should be wound on the pipe, but he did not say so in his article or show it on the drawing, so if anyone should make such a heater, following only the specifications given, he might be very much surprised by the fireworks which would follow the closing of the switch. C. H. MCKELWAY.

Westfield, N. J.

[The author in the foregoing has taken an extreme case in the size of wire used. A No. 10 B.w.g. iron would be a pretty stout affair to handle and wind on the heater described. However, as Mr. McKelway points out, it would be difficult to get sufficient wire in one layer on a 3-ft. length of 3-in. pipe to keep the current within reasonable limits. Undoubtedly, Mr. White in describing the heater had in mind his experience in the field, where heaters are made up from almost anything from wire to junk iron and pipe, and failed to check the capacity of the heater he suggested. If the heater is wound with 600 ft. of No. 20 B.w.g. iron wire, it will be satisfactory to operate on 110 volts. Two such heaters connected in series will operate on 220 volts. In no case should there be more than one layer placed on the heater.—EDITOR.]

With the Heater Flooded, What Would Happen When Starting Up?

In the Jan. 3 issue of *Power*, page 31, J. P. Burggraf inquires as to what would happen to his engine or heater if he started the engine to full speed when the heater was half filled with water. In my opinion the exhaust would force the water out through the vertical exhaust pipe, provided the heater and connections remained intact. The water, however, would not back up into the engine cylinder while the engine was running at a fair rate of speed, but if it was turning over slowly, the water in the heater would back through the exhaust pipe and exhaust valves into the cylinder. This water, being caught between the cylinder head and the piston, would either stop the engine or blow out the cylinder head.

Mr. Burggraf did the proper thing when he stopped the engine, because it is likely that if he had brought it up to full speed at once some part of the heater would have failed, on account of water hammer caused by the accumulated water in the heater and the entering exhaust. PATRICK MOLLOY.

New York City.

Breaking of Connecting-Rod Wedge Bolts

Referring to G. B.'s quotation and the answer, page 906 of the Dec. 6, 1921, issue of *Power*, the cause of the breakage of the wedge bolts has been pretty well covered. As to the remedy I think that I have it. I have tried it on a number of engines, both small and large, and in every case was pleased with the results.

Using the ordinary bolt, just turn down a portion of the shank between the head and the threads to about the diameter of the base of the threads, leaving a fillet under the head as large as possible. If new bolts are to be made, an even larger fillet can be provided and a little countersinking done in the hole over several inches of its length to relieve the excessive strains close up under the head. I have a bolt working that has been in a year and a half, where an ordinary bolt would not last more than two weeks.

Ponca City, Okla. PHILIP R. DUNTON.

QUESTIONS AND ANSWERS

Holes in Boiler Heads for Through-and-Through Stays

Are the holes in the heads of a return-tubular boiler for through-and-through stays the same size as the body of the stays? W. E. T.

Through-and-through stays usually have their ends enlarged by upsetting, so the diameter of the screwed ends for receiving the nuts may be large enough at the roots of the screw threads to afford the same strength as the body of the stay. For that purpose the diameter at the root of the screw threads should be somewhat greater than the diameter of the body of the stay and holes for entering the stay must be still larger, for they must be large enough to receive the outside diameter of the screw threads.

Heat Transferred Through Condenser Piping

How much heat will a square foot of condenser surface transmit from ammonia vapor at a temperature of 280 deg. to cooling water at 60 deg.? R. G. C.

The heat transferred is found by the equation,

$$H = K\left(\frac{t_1 - t_2}{2}\right)$$

when K is the coefficient of heat transmission of pipe per square foot per degree of temperature difference per hour, t_1 is the temperature of ammonia and t_2 is the temperature of cooling water. In this case, assuming $K = 30$ B.t.u., the equation becomes

$$H = 30\left(\frac{280 - 60}{2}\right) = 3{,}300 \text{ } B.t.u.$$

per square foot of surface per hour.

Adiabatic Expansion Lowers Quality of Steam

When using a throttling calorimeter to determine the moisture in steam the steam on the low-pressure side of the aperture is superheated owing to the drop in pressure. In turbine practice, after saturated steam has passed through a nozzle the steam contains more moisture than before. Why should not the steam be superheated in each case? H. J. P.

In a throttling calorimeter the sample of steam taken into the instrument can lose no heat except by radiation, and since the calorimeter is small, the amount of heat lost in this way may be neglected. Therefore, as far as practical results are concerned, the steam in the calorimeter contains the same number of heat units per pound weight of the steam as the steam in the pipe from which the sample is taken. As the low-pressure steam in the calorimeter requires less heat for a saturated condition than high-pressure steam that is discharged into the calorimeter, there will be more heat than necessary for saturated condition after the pressure has been reduced, and as this excess heat cannot escape, it is absorbed by the steam in the calorimeter, thereby raising its temperature or superheating the steam to a temperature higher than the temperature of dry saturated steam of the pressure in the calorimeter.

The form of a turbine nozzle is such that the steam in passing through the nozzle closely follows adiabatic expansion in its progress from the throat to the mouth, and part of the heat contained in the initial steam is converted into work of imparting velocity. In good forms of turbine nozzles so much of the heat is thus employed that unless the initial steam was sufficiently superheated, the steam, after expansion to the pressure at the mouth of the nozzle, contains less heat per pound than necessary for all the steam to exist as dry saturated steam at the reduced pressure. Consequently, after expansion, that part of the initial weight of steam for which there is not enough heat to supply the latent heat of evaporation required at the reduced pressure must exist in form of moisture.

Compressed Air Delivered by Pipe Line

What is the formula for the volume of compressed air of given initial and final pressures discharged per minute through a pipe line? F. D. C.

A simple formula of discharge is

$$D = c\sqrt{\frac{d^5 (p_1 - p_2)}{w_1 l}} \text{ or } D = \frac{c\sqrt{d^5}}{\sqrt{l}} \times \sqrt{\frac{p_1 - p_2}{w_1}}$$

in which

D = Volume of compressed air in cubic feet per minute discharged at the final pressure;
c = A co-efficient, varying with the diameter of the pipe, as determined by experiment;
d = Diameter of pipe in inches;
l = Length of pipe in feet;
p_1 = Initial gage pressure in pounds per square inch;
p_2 = Final gage pressure in pounds per square inch;
w_1 = Density of the air, or its weight in pounds per cubic foot at the initial pressure p_1.

The values of c are: For a pipe 1 in. in diameter, 45.3; 2 in., 52.6; 3 in., 56.5; 4 in., 58; 5 in., 59; 6 in., 59.8; 8 in., 60.7; 10 in., 61; 12 in., 62.

The values of w_1 are: For a gage pressure of 50 lb., 0.3348; for 60 lb., 0.3866; for 70 lb., 0.4383; for 80 lb., 0.4901; for 90 lb., 0.5418; and for 100 lb., 0.5936.

Air-Injection and Solid-Injection Engine

What is the difference between an air-injection and solid-injection Diesel engine? R. L. N.

In the air-injection engine the oil is deposited in a cavity about the base of a needle valve. Air at the pressure of about 1,000 lb. per sq.in. fills the cavity above the oil. When the needle valve opens, this high-

pressure air forces the oil through a series of holes into the engine cylinder. The air is the force which compels the oil flow and also acts as an atomizing agent, breaking the oil into a fine fog. It has the disadvantage of chilling the cylinder air charge, requiring a higher compression pressure than otherwise would be required.

The solid-injection engine uses no air, but the oil is jetted through a nozzle into the cylinder by direct pressure from the oil pump. The compression pressure may be lower, but the atomization usually is not so complete as with air injection.

Changing from Non-Condensing to Condensing

In changing the operation of a single-eccentric Corliss engine from non-condensing to condensing, what changes of valve gear should be made? H. B. K.

For the same load and same initial steam pressure, the governor would effect shorter cutoff with regulation of the engine at a higher speed, and for adjustment to the same speed some of the governor loading would need to be removed. The main change required from normal valve setting would be earlier closure of the exhaust, to obtain the same cushioning. That would be obtained by advancing the eccentric, if found necessary to restore smooth running of the engine. As advancing the eccentric hastens all valve events, it would increase the lead of the steam valves and the original amount of lead could be obtained by adjustment of the length of the steam-valve rods.

Fluctuating Voltage Causes Circuit Breaker to Open

We have a 50-hp. 230-volt direct-current motor that operates on the end of a long feeder. At another point on the feeder is a 100-hp. motor operating under a fluctuating load. When this motor is carrying full load, the voltage at the end of the feeder drops to about 200, and when operating at no load the voltage will increase to about 230, which is the normal voltage of the motor. When the load is suddenly thrown off the 100-hp. motor, the circuit breaker protecting the 50-hp. machine has been caused to open and has also caused the motor to flash badly at the brushes and commutators. Why should the circuit breaker open on the 50-hp. motor when the load is taken off the 100-hp. machine, and what may be done to prevent this and the sparking at the brushes? A. R. B.

At full load the 50-hp. motor will take about 200 amperes, and when this current is being transmitted over the feeder, assume that it causes 10 volts drop; that is, there are 240 at the switchboard and 230 at the motor. The resistance of the feeder is equal to volts drop divided by amperes, or in this case $10 \div 200 = 0.05$ ohm. We can also assume the same resistance, 0.05 ohm, for the armature circuit of the motor, so that under full load the drop through the armature will be 10 volts. The counter-electromotive force equals the line volts minus the volts drop in the armature. With the 100-hp. motor on the feeder, the line volts at the 50-hp. motor is only 200, therefore the counter-electromotive force is $200 - 10 = 190$ volts. With the 50-hp. motor on the line only, the total resistance of the circuit is the sum of that of the line and motor, or $0.05 + 0.05 = 0.1$ ohm. When the load drops off the 100-hp. motor, the 50-hp. machine is running at a speed corresponding to 200 volts and generating 190 volts counter-electromotive force. Therefore the condition in the 50-hp. motor circuit is one where 240 volts is applied to a circuit of 0.1 ohm having 190 volts counter-electromotive force generated in it. The current that will flow under this condition equals the difference between the applied volts and the counter-electromotive force divided by the resistance in ohms, or $(240 - 190) \div 0.1 = 500$ amperes. From this it is seen that at the instant that the 100-hp. motor's load is taken off the circuit, the current through the 50-hp. machine tends to increase to 500 amperes. However, it will not reach this value owing to the inductance of the circuit, but it can easily reach a value that will trip the circuit breaker before the motor can increase in speed to that corresponding to 230 volts.

One of the best remedies for the trouble will be to put the 100-hp. motor on the present feeder and run a second feeder to the 50-hp. machine. If it is desired to obtain better voltage regulation at the 100-hp. motor, then run a larger feeder to this motor and use the present feeder for the 50-hp. unit.

"Heavy" or "Light" Pressure Gage

In checking up a pressure gage on a steam line, it is found that the gage shows 10 lb. higher than the actual pressure. Under the conditions is it proper to say that the gage is heavy or that it is light? E. M.

A pressure gage is said to be "heavy" when the pressure which it indicates is higher than the true pressure, and is said to be "light" when the pressure indicated is lower than the true pressure. The indications of a pressure gage rarely are the same amount higher or lower than true pressure throughout the whole range of pressures indicated and a statement that the gage is 10 lb. heavy or light would be inexplicit unless coupled with a statement of true pressures at which the error occurs. When compared with a calibrated test gage, the indications may be correct for the true pressure of 5 lb., but 10 lb. "heavy" or "light" for a true pressure of 50 lb. per square inch.

Maximum CO_2 Burning Fuel Oil

What is the most economical percentage of CO_2 to obtain in flue gases from combustion of fuel oil in boiler furnaces? P. E. C.

For fuel oil of average analysis, theoretically perfect combustion would yield about 15.7 per cent of CO_2 in the flue gases. It must not be understood, however, that the air supply should be cut down to the extent necessary for obtaining such a high percentage of CO_2, for, as in burning other fuels, the best results are obtained when the excess air is the minimum that will completely consume the oil. The percentage of CO_2 giving highest boiler economy in any instance must be determined for the fuel analysis, burners and other special conditions. A perfectly clear stack indicates excess air and smoke indicates a deficiency of air. With a well-designed furnace the best results are obtained by running near to an appearance of smoke with a slight haze in the gases. Under this condition the percentage of CO_2 usually will be a little under rather than over 14 per cent, with no more than a trace of CO.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Corrosion and Its Cure*

The various engineering societies for the current year have made the keynote of their programs "Waste Prevention." Corrosion is, in general, not a preventable waste, but much good may be accomplished in certain narrow fields to which it is intended to confine this talk.

The question of boiler corrosion is a difficult one. It may be ascribed either to bad water or, on the contrary, to the use of unusually pure water. It may be due to high rating, low rating or stand-by service. Idle boilers ordinarily give the most trouble, while those operating under low loads come next. Boilers operating at normal ratings usually are immune from corrosion, excepting that due to the dissolved solids in the feed water. At extremely high ratings, however, the subject of corrosion again appears as a limiting and decisive factor.

The rough general statement may be made that corrosion occurs where water, oxygen and a common metal are present. If either the oxygen or the water be removed from the combination, corrosion, from a practical standpoint, ceases. The metals ordinarily used to carry water in engineering works are iron or copper alloy. In the following, reference is made directly to iron as being the metal under discussion. The points brought out, however, may be applied to copper alloys or copper, with the understanding that where an alloy is involved the action is selective with the different ingredients of the alloy, and does not involve a general wasting.

The actual dissolving of iron by pure water is so small as to be of no practical importance. The presence of oxygen, however, makes a great difference so that the water will go on dissolving the iron indefinitely until either the iron or the oxygen is consumed. It is for this reason that oxygen is ordinarily considered as the corroding agent. The action is really of an electrochemical nature. Certain types of dissolved solids, notably magnesium salts, tend to accelerate the rate of corrosion.

Useful Life of Iron and Steel Pipe About the Same

It appears, as far as the expectation of useful life is concerned, that iron and steel pipes are on a parity. This is not altogether consistent with an existing opinion that wrought-iron pipe exhibits greater resistance to corrosion than steel pipe. Commercial wrought-iron pipe of today still exhibits the fibrous structure of wrought iron, but from a corrosion viewpoint its characteristics are not those that are usually associated with wrought iron. It is questionable, therefore, whether the present liability to corrosion is due to poor grades of so-called wrought iron or whether the original opinion ascribing immunity to it was not in error. The characteristics of the two metals, as far as corrosion appearance is concerned, are quite distinct, since the pitting of the steel pipe exhibits a uniform spacing, while that of the wrought iron closely follows the fiber structure.

Not all the products of corrosion remain suspended in the water. Ordinarily, the greater part of them adhere to the interior of the pipe. An analysis of the scale or corrosion products ordinarily indicates perhaps 15 per cent to be insoluble calcium compounds, which are mechanically mixed with the various oxides of iron. As a result, in severe cases of pipe corrosion, unless the velocities are higher than those usually encountered in domestic service, the pipes become either totally or partly stopped.

The average life of iron pipe in the worst localities is five years. In other localities it may extend to as much as fifteen years, and some pipe lines in the Great Lakes region have gone as high as eighteen years. Ordinarily, the most accelerated conditions of corrosion occur, of course, with high water temperatures, and it is only under such conditions that it pays to protect the system. As the speed of corrosion depends very much upon the temperature of the water, it is hard to make any general statement, except that, on the average, the useful life of a building exceeds the life of the pipe.

The remedy is not ordinarily found in substituting brass pipe for iron pipe. It may be generally expected that brass pipe will have a life slightly greater than twice that of iron, but the behavior is sometimes very erratic. In some cases brass-pipe life has been less than that of iron.

Steel-tube economizers exhibit roughly the same corrosion phenomena as pipe, except that the corrosion is ordinarily concentrated upon pit-hole localities rather than distributed as widely as in pipe. Cast-iron economizers ordinarily show wasting and are particularly susceptible to corrosion with high water velocities and unusually pure water. They have, however, a much higher resistance to corrosion than steel.

Economizers have invariably shown a longer useful life at high temperatures than at low, because the heating of the water eliminates to a fair degree the dissolved oxygen. It is often perfectly feasible to operate a cast-iron economizer at high temperatures without any attempt at removing the air, except very liberal venting of steam from open feed-water heaters. It does not seem economically safe to operate steel-tube economizers without some means of removing the air. From the heat-balance point of view the economizer does its greatest good when the water comes to it at a low temperature. This, however, will in most cases be impracticable unless there is some means of first removing the air.

The corrosion in boilers occurs either at the dead line or in dead circulation places in boilers that are not operated at extremely high ratings. It is probably true, however, that corrosion from dissolved gases is not a serious factor in boilers operating on natural water. If any scaling is present, the scale, while retarding the heat flow, also serves as a protective coating against corrosive action.

Probably the most satisfactory method of preventing corrosion is to remove the air from the water. This attacks the trouble at its source. There are a number of processes to accomplish this end, but the writer will speak only of the Elliott process. In this process the water, heated to a predetermined temperature below its boiling point, is suddenly admitted into a region of vacuum, where it boils explosively at the expense of the heat of the liquid. This explosive boiling results in a minute pulverization of the water as the liquid flashes into steam and passes off into the region of the separating chambers. In the space here available it is not possible to go into a description of this apparatus further, except to say that it effects a separation of the air from the water and also permits of the recovery of the heat used to produce the explosive boiling.

*Abstract of paper presented before the Minnesota Chapter of the American Society of Heating and Ventilating Engineers, Jan. 9, 1922, by J. R. McDermet, research engineer, Elliott Co.

American Engineering Council Holds First Annual Meeting

With a year of good work behind it and every indication of increased success in the future to look forward to, American Engineering Council of the Federated American Engineering Societies held its first annual meeting Jan. 5 and 6 in Washington, and gave a dinner in honor of its first president, Herbert Hoover. The meeting was held in the Cosmos Club and was in charge of Dean Mortimer E. Cooley, of the University of Michigan, who was elected president of the Federation some months ago to take the place of Mr. Hoover when he became Secretary of Commerce. The activities of the past year were reviewed, a number of business matters were attended to, and general plans for the coming year were mapped out.

There was a good deal of discussion as to whether the Council formally approved or disapproved of the principle of licensing or registering engineers, which has been adopted by several states and is being considered by a number of others. No decision was reached, however, but a committee was appointed to study the question and to report at the next meeting of the executive board.

Among the accomplishments of the year was mentioned the securing of employment for 1,221 engineers in the first eleven months of 1921.

Regarding the question of membership the Engineers Club, of Columbus, Ohio, was added to the list, and Executive Secretary Wallace reported that at the present time,

with one possible exception, no society will withdraw from the Federation, and there are more than twenty active prospective members. He reported also that at the end of 1921 there were eight national and twenty state and local societies included in the membership. He urged an agressive campaign for more members, with the object of including practically every engineering society in the country.

As for finances, Mr. Wallace said: "The financial situation is not such as to cause alarm. Careful management and the results to be expected from an active campaign for new members, should enable the Federation to perform its work for 1922 without a deficit."

It is understood that plans for the coming year include a study of the Water Power Act and its application, with the idea of making suggestions as to its administration or of proposing amendments to the act itself if that seems necessary.

It was reported that inquiries about the work of the Council's Committee on the Elimination of Waste in Industry are coming in from all over the world, and that the report is being studied by numerous engineering, civic and economic organizations. Of interest in this connection was the request of Dr. B. Stepanek, Minister to the United States from Czecho Slovakia, who has asked and received copyright privileges on the book, "Waste in Industry."

About one hundred gathered for the dinner to Mr. Hoover, over which Dean Cooley presided. The four vice presidents presented Mr. Hoover with a resolution of the Council, in in which was expressed appreciation of his leadership, regret for his resignation, and "sincere good wishes for a continuation of that distinguished success which has followed him in his past services to his profession, his country and mankind."

The chief feature of the evening was, of course, Mr. Hoover's speech, in which he praised without stint both the Federation and the Elimination of Waste Committee. He felt that the investigation had got the country as a whole to thinking about fundamental questions of industrial waste and standards of living, and that another result had been to establish the engineer in public confidence as one devoted to the highest social, economic and political ideals of the state. He stressed the importance of finding and stopping every possible avoidable waste in industry to bring down prices, which are due, he said, to difficulties of manufacturing, transportation, distribution, and to idle men, rather than to swollen profits.

Mr. Hoover not only approves the Superpower project, but called upon electrical engineers to extend the idea of electrification over the entire country as a part of the elimination of waste program.

Wooton-Bowden Plan for St. Lawrence Recommended

The plan of Col. W. P. Wooton and W. A. Bowden for developing the navigation and power possibilities of the St. Lawrence River was indorsed by the International Joint Commission in a report submitted to Congress Jan. 16. Colonel Wooton and Mr. Bowden are engineers who were appointed by the United States and Canadian governments respectively to study the improvement of the river. In the Senate the report was referred at once to the Committee on Foreign Relations, but in the House there was a dispute as to whether it should go to the Committee on Foreign Affairs or to that on Rivers and Harbors.

The Commission's report takes the position that navigation of the river is the first requirement and that only so much power should be developed as will not interfere with navigation. It is proposed that Canada and the United States should make a treaty providing for the river's improvement.

The Commission believes that the best use of the waters of the St. Lawrence River between Montreal and Lake Ontario may be obtained by a combination of navigation and power development in the international section and of navigation alone in the national section, with power development there at some future time.

The estimated cost of the completed work between Montreal and Lake Ontario, as recommended by the Engineering Board, is about $252,000,000. To this must be added the cost of the New Welland Ship Canal, which the Commission believes should be included in the project.

So far as the physical features of the improvement are concerned, the Commission believes that the works at and near the Long Sault Rapids, whose completion may be expected to require the greatest amount of time, should be begun as soon as funds are available; and that all other works, both in the international and national sections of the river, should be started in time to insure their completion at approximately the same time as the Long Sault works.

According to the Commission, those who have given particular attention to this matter, both in the United States and Canada, are for the most part of the opinion that markets will be available to absorb all the power that can be developed on the international section of the St. Lawrence, within a reasonable period after the completion of the proposed works. The Commission has data indicating that at the present time the total primary power installation on the United States side of an area within a radius of 300 miles of Long Sault Rapids is approximately 9,900,000 hp., and on the Canadian side 1,900,000 hp. The estimated demand on the United States side in 1925 is 11,000,000 hp. and on the Canadian side 2,350,000 hp.; and in 1930 on the United States side, 12,500,000 hp. and on the Canadian side 2,875,000 hp.

It will be noted that the Director of the U. S. Geological Survey is of the opinion that "the demand in New York and New England would take care of all the power that might be developed on the St. Lawrence as soon as it was made available," and that this opinion is confirmed by the Report on the proposed Superpower System. Evidence as to the demand on the Canadian side of the area goes to show that ultimately Canada will be in a position to use her share of the available power on the international section of the St. Lawrence, although obviously for some years after the works are completed, there will be a much greater demand for power by the United States than by Canada.

Patent Office Relief Bill Passed

By the overwhelming vote of 305 to 44, the House of Representatives has at last passed the Patent Office relief bill against the opposition of such influential members as Majority Leader Mondell and Chairman Madden of the Appropriations Committee. The Senate Committee on Patents expects to consider the bill immediately, and it is known that a majority of the committee favors reporting it to the Senate as soon as possible.

The opposition to the measure was based largely on the ground that increases in salary of as much as 50 per cent, in some cases, are being allowed to one group of employees. Of course, if the same salary scale were applied to the 300,000 other employees of the Government, outside the postal service, it would mean a tremendous increase in the Federal expenditure.

Messrs. Mondell and Madden urged that the Patent Office employees await the passage of the Lehlbach reclassification bill, which already has passed the House, and which the Senate expects to pass before April 1. While that measure does not call for such high salaries as those in the Patent Office relief bill, it was argued that the Lehlbach increases are all that are justifiable at this time. Mr. Mondell argued that the proposed rates are too high and the personnel provided is unnecessarily large.

The three main provisions of the bill are: A substantial increase in salaries, particularly to the technical employees of the Patent Office; an increase in personnel; and authority for raising patent fees to cover the increased expenditures.

The deplorable condition of the Patent Office, resulting from salaries that have been raised only 10 per cent since 1848, has been given publicity by engineering societies and other organizations. The old Engineering Council and its successor, American Engineering Council, have been active in giving this publicity, and a measure of credit is due both bodies for the progress that has been made toward putting the country's patent affairs on a business basis.

Condensed-Clipping Index of Equipment

Patented Aug. 20, 1918

A New Precision Instrument

Young-Fischer Inclinometer Co., Milwaukee, Wis.

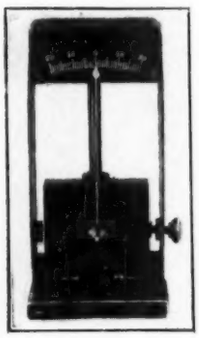
"Power," 1922

There has been recently placed on the market an instrument known as an inclinometer, intended to take the place of the plumb level, or protractor, and also of the sine-bar in mechanical laboratories, machine shops and all building operations where angles are to be determined and particularly where extreme accuracy is required. It has a cast metal case containing an adjusted gear train driven by gravity impulse. The hand on the degree dial moves in unison with the impulse, and the hand on the minute dial is driven by the multiplying gears causing the minute hand to make 36 revolutions while the degree hand makes one revolution. The multiplying effect of the gear train is such that the instrument gives angle readings in both degrees and minutes with an accuracy corresponding with that of a single-dial inclinometer having a dial ten feet in diameter. It indicates directly, not only the vertical and horizontal, but any angle as well.

Indicator, Vibration Amplitude

General Electric Co., Schenectady, N. Y.

"Power," Oct. 25, 1921

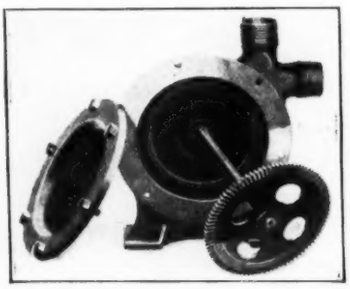


This vibration indicator has been developed to measure quantitatively the motion of vibration of any external portion of a turbine generator set either transverse or longitudinally. The scale is calibrated in thousandths of an inch. The indicator consists of a cage supporting a relatively heavy weight as a pendulum. When the cage is placed on the part to be tested, the motion of the part is transmitted to the cage, while the weight remains sationary. The relative motion between the cage and the weight actuates a pointer which measures the amount of the motion definitely and accurately. The ability to determine definitely the effect of any change in the balance weight or other conditions, is an improvement over former methods, which depended on individual memory and judgment.

Pump, Westco Rotating

The Western Pump Co., Davenport, Iowa.

"Power," Nov. 29, 1921



A distinctive feature of this pump is that there is but one moving part, a bronze or alloy impeller secured to a Monel metal shaft, the impeller having a certain determined number of blades on each side of the outer rim. The rotating impeller causes the water to be drawn from the source of supply and discharged under pressure at the periphery. It is motor-driven. The bearings are of the radial ball-thrust type and are packed with grease. The pump is made for standard 1,800 r.p.m. electric motors, which generally operate under full low speed at 1,750 r.p.m. It is also built for belt connections to gas engines or line shafts.

Thermometer, Sarco (Fournier)

Sarco Co., Inc., Woolworth Building, New York City.

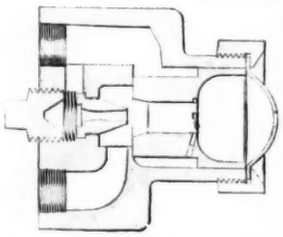
"Power," 1922

This instrument is of the saturated vapor type, and the pressure within the apparatus is unvaried for any given temperature and changes only with the temperature, irrespective of any other outside influences. It is made for any temperature from minus 90 deg. F. to plus 1,300 deg. F. One of the most important features of the apparatus is the use of more than one liquid or gas filling. For instance, where conditions require it, a thermometer is made with a saturated vapor in the bulb and a liquid filling the transmission tube. The liquid in the transmission tube is of a low coefficient of expansion, and as a result the thermometer can be furnished with practically any desired length of connection tubing, say, up to 500 ft.

Burner, Enco Oil

Engineer Co., 17 Battery Place, New York City.

"Power," Nov. 15, 1921

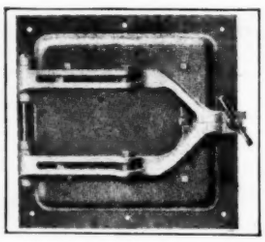


This burner is designed to burn low-gravity oil in both large and small quantities with minimum oil and steam or air pressure, and has the ability to produce a flame of any size or shape. The arrangement of the venturi nozzle in its relation to the longitudinal hole creates an injector which permits heavy oil and tar to be fed to the burner at low pressures. Fuel is not driven through the flame plate at a high velocity, as the driving force of the jet entering through the venturi tube, while sufficient to partly atomize the fuel, is practically expended before it reaches its chamber. The action of the tangential jets is practically exhausted by the whirling motion within the mixing chamber, and the atomization is completed before the mixture passes through the flame plate. The fuel is therefore ready for combustion upon leaving the burner.

Door, American Air-Tight

Conveyors Corporation of America, Chicago, Ill.

"Power," 1922

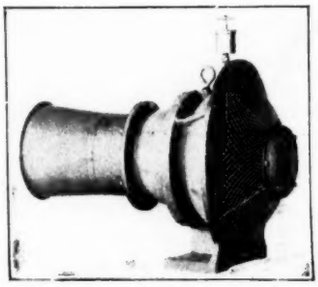


It is of heavy cast iron, has a ventilated cast-iron liner, and the bearing surface of the door is machined to make an air-tight joint with the frame. The hinge bars are of the floating type, with two hinges, the bars uniting at one locking point. The door is pivoted and hung at the center from the hinge bars so that the pressure is maintained at all points of contact with the frame. The door is locked by means of a wing nut at the end of the hinge bar. It is made in four sizes: 18 x 18, 22 x 26, 24 x 24 and 24 x 36 inches.

Blower, Coppus "Vane"

Coppus Engineering and Equipment Co., Worcester, Mass.

"Power," Nov. 22, 1921

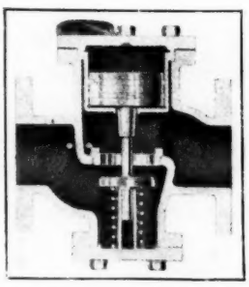


This blower is of the screw-blade propeller type and delivers air in the same direction as it enters. It operates against pressures up to 8 in. of water and can be employed where, until now, only centrifugal blowers could be used. Its efficiency runs up to 80 per cent for both high and low pressures, and the power consumption at constant speed is practically unaffected by variation in air delivery or pressure. The principal feature is the stationary guide vane beyond the impellor, which radially subdivides the air current and gives a curvature which increases in the direction of the rotation of the propeller, concentrates the air current and gives it a further acceleration inside the stationary guide.

Regulator, Watts Pressure

Watts Regulator Co., 142 High St., Boston, Mass.

"Power," 1922



Watts pressure regulator is designed to maintain a constant delivery pressure regardless of fluctuations in the initial pressure. It is a single-seated valve, auxiliary operated, having a phosphor bronze diaphragm. It contains but three moving parts. Steam passes to a pilot valve and then to the top of a piston that moves the main valve against the action of a spring and the initial pressure on the bottom of the main valve to full open position, permitting the flow of steam into the service line. As the reduced pressure increases in the service line, it passes to a chamber, and when the pressure reaches a point at which the valve is set, it moves a diaphragm against a spring, which allows the pilot valve to close, cutting off the pressure from the top of the piston. A spring immediately closes the main valve, shutting off the supply of steam through the regulator.

Clip, paste on 3 x 5-in. cards and file as desired

News in the Field of Power

Civil Engineers See How Magazines Are Made

The McGraw-Hill Co. made quite a contribution to the program of the American Society of Civil Engineers' Annual Meeting in New York City last week, by inviting all interested members to a luncheon and inspection of the plant where *Power* and ten other engineering and business magazines are published. The affair was, of course, under the direction of *Engineering News-Record*, the McGraw-Hill Co.'s civil-engineering paper, but members of the staff of all the papers joined in welcoming the engineers and in showing them over the building. The visitors were taken over the entire establishment, from the accounting and subscription departments on the thirteenth floor down through the editorial floor, the complete printing department, the drafting room, the art department, the bindery, etc., thus receiving a good idea of the great amount of mechanical equipment behind the McGraw-Hill publications.

Government Buildings Making Too Much Smoke

Health Officer Fowler of the District of Columbia was called recently before the House Committee on Appropriations for information as to enforcement of the anti-smoke law in the District. Representative Slemp, in pointing out that bituminous coal burned in Government buildings caused a minimum of smoke, asked why the District authorities insisted on the Post Office Department's using anthracite and bituminous on a fifty-fifty basis instead of 10 per cent anthracite and 90 per cent bituminous.

Mr. Fowler replied that the District did not prescribe the kind of fuel to be used, but simply enforced the law, which prohibits dense smoke or cinders, but makes no reference to the kind of fuel to be used. Out of 97 observations of the Post Office Department, he said there had been 21 violations of the law, which he laid to improper firing.

Mr. Fowler said also that he recently had met representatives of the Government buildings on the smoke question and had advised them that the smoke was due to improper firing of boilers, although they laid the blame on the fuel. The latter was denied by the Bureau of Mines fuel yard, which claimed that it was good fuel.

G. E. Supplying Alabama Generators

Three of the four generators at the Alabama Power Co.'s new Mitchell Dam development have been bought from the G. E. Company, not from the Westinghouse company as reported in *Power* for Jan. 3. The contract for the fourth machine has not at this writing been awarded.

These generators will be of the vertical type, driven by Allis-Chalmers hydraulic turbines. They will be rated at 20,000 kva., 6,600 volts and 100 rpm.

Council Working for Better Engineering in Government

The need for reorganization of the engineering departments of the nation and of New York State is being emphasized by American Engineering Council, which has just passed a resolution in strong praise of Governor Miller's recent plea for consolidation of New York State departments. In his message to the legislature, the Governor called attention to the unnecessary duplication of effort between the Department of Public Works, the State Engineer's Office, the Department of Highways, the State Architect and the Department of Public Buildings.

The Council's resolution expressed its "unqualified approval of the suggestion of the Governor of the State of New York and offers its services through its New York State Government Reorganization Committee in aid of a constructive program."

It is reported that the Council's efforts to co-ordinate the national engineering departments are likely to be successful; the final decision, it is said, will probably be as follows: The Department of the Interior will be subdivided into the division of public domain and the division of public works. In the latter will be assembled almost all of the governmental activities that the engineers have advised putting into the Department of Public Works. The variations from the recommendations of the engineers are not material.

The Council has also announced its intention of continuing the campaign for reforming conditions in the United States Patent Office, even though the Lampert Bill, framed to afford patent relief, has passed the House.

Philadelphia Backs Fair to the Limit

Another step toward the 1926 Sesqui-Centennial Exhibition in Philadelphia was taken Jan. 19 when the Philadelphia city council pledged for the project "$5,000,000 and as much more as may be needed" by a vote of 19 to 1. In Washington the Pennsylvania congressional delegation has endorsed the Exhibition and is working for a Federal appropriation. The Big Fair seems well on its way.

Permit Asked for Columbia River Development

Col. Hugh L. Cooper has applied to the Federal Power Commission for a preliminary permit covering the important Grande Coulee Site on the Columbia River in the State of Washington. This project is covered in the Columbia Basin report issued by the State of Washington. In that report it is stated that a dam 180 ft. high could be erected at the Grande Coulee Site. The Federal Power Commission, using the existing records of the flow of the Columbia River, figures that such a dam would permit of the development of 430,000 hp. Since the principal use of the power would be for irrigation purposes, it is believed that on a pumping load basis it would be possible to install 1,000,000 horsepower.

Preparing for Coal Strike

The Government is making preparations to do everything possible toward the prevention of a coal strike when the wage agreements expire in April. It is expected that the operators will try to bring wages down, while the miners will probably insist on the present scale, or possibly a higher one. The Government's efforts will be toward keeping up production during settlement of the dispute, and to getting the miners and operators together with the least possible ill-feeling.

It is understood that several Cabinet officers have become particularly interested in an early settlement and that the Administration's activities in this connection will be centered under Secretary of Commerce Hoover, with Secretary of Labor Davis gathering all possible data on the question.

New Englanders Oppose Oil Duty

In opposing the proposed duty on imported oil representatives of New England consuming interests at Washington have said that Midcontinent fuel oil for use in boiler plants could not compete with coal along the Atlantic seaboard. If Mexican oil were curtailed by the proposed duty, they believe, European and South American countries would compete for it, and Eastern railways would not have available a sufficient number of cars to handle the required coal. It was said also that the substitution of coal for fuel oil in plants now using oil would cause the scrapping of millions of dollars worth of expensive equipment.

An engineer's license law will go into effect in West Virginia Jan. 27. The law is not compulsory, but those who receive licenses may call themselves "registered professional engineers," and engineers without licenses will have to practice without referring to themselves by this term.

Austrian Company Plans 450,000 Hp. Hydro-Electric Development

An ambitious program of water-power development that is under way in Austria provides for a series of plants with an ultimate capacity of 450,000 hp., which is considered about one-quarter or one-fifth of the amount of Austrian water power that might profitably be utilized.

The plants will be tied in through high-tension mains of 60,000 and 100,000 volts and will be supplemented by one or more steam plants using brown coal.

The work is to be undertaken by the Styrian Water Power and Electricity Co., Ltd., of the City of Graz, Austria. It is planned to have the project completed in 15 years, although under favorable conditions this period may be shortened.

The company now has a capital of 20,000,000 kronen, which was subscribed by the Province of Styria, the City of Graz, and Styrian industrialists.

Additional funds are being secured by public subscription through a number of banks, among which is the Anglo-Austrian Bank, represented in this country by R. M. Bauer & Co., 25 Broadway, New York City.

New Publications

Essentials of Industrial Costing. By George S. Armstrong. Published by D. Appleton & Co., New York City. Cloth, 5½ x 8¾ in.; 285 pages; 80 figures and tables. Price, $5.

It is now generally admitted that the subject of cost accounting is vitally related to the nation's prosperity. This book, while giving a broad view of the subject, is distinctly practical in its aim and method, the general statements of principle being always followed by specific data and examples. Of particular interest to power-plant engineers is the part of Chapter X, in which heat, light and power are discussed. The author starts this section with the frank admission that a knowledge of engineering is more important than that of accounting so far as the correct determination and distribution of power costs are concerned. He follows this with a brief elementary statement of the pertinent engineering principles that should be of interest to accountants.

The Edge Moor Water-Tube Boiler. Published by Edge Moor Iron Co., Edge Moor, Del. Cloth; 6 x 9 in., 152 pages.

This book is something more than a substantially bound and well-printed treatise on the Edge Moor Water Tube Boiler and its application. A considerable amount of general information of interest to all who are concerned with steam generation is included. Much of this is scattered through the first hundred pages of the book, which deal primarily with the construction and applications of this boiler. The main subjects treated in this first section are: Development and construction of the Edge Moor boilers; baffling and stokers; firing with oil; waste-heat boilers. The remainder of the volume is given over entirely to engineering data of general interest to boiler operators. Some of the important subjects covered in this section are as follows: Fuels; combustion; factors affecting efficiency; feedwater; priming; properties of steam; flues and stacks; testing instruments and miscellaneous information. The book is furnished free of charge to those interested in the engineering details of the Edge Moor Boiler.

Protective Relays. By Victor H. Todd. Published by McGraw-Hill Book Co., Inc., New York City, 1922. Cloth; 5½ x 8 in.; 274 pages; 244 illustrations. Price, $2.50.

This book deals with the theory, design and operation of protective-relay systems. An attempt has been made to cover the subject from the first principles of protecting electric circuits to the protection of high-tension networks, by protective relays. A large percentage of the material was published in *Power* and other technical journals in the form of articles. This material the author has revised and brought up to date and has added new material where necessary to make the treatment comprehensive.

The work is divided into seventeen chapters: What are protective relays?; circuit breakers and releases; trip circuits and time delays; plunger-type protective relays; direct-current power-directional relays; applications of direct-current power-directional relays; induction-type current relays; alternating-current power-directional relays; characteristics of alternating-current disturbances; instrument transformers and groupings; protection of motors, transformers, generators and lines; protection of parallel feeders; protection of radial ring and network systems; miscellaneous relays; testing direct-current relays; testing alternating-current relays; locating faults in feeders and wiring.

In the preparation of the material the object has been to make the book meet the needs of operating engineers and testers, and in this respect the author has produced a commendable work. However, designers of protective-relay systems will find in the book much of interest to them, as also will the student of electricity.

Personals

Peter H. Bullock, of Concord, Mass., is retiring after 54 years' work as mechanic and engineer, of which 42 years have been as chief engineer of the Massachusetts Reformatory.

G. B. Shawner, for eleven years superintendent of the City Water and Light Plant of Springfield, Tenn., is now manager of the Smith County Electric Co., at Carthage, Tenn.

John A. Stevens is to sail for Egypt Feb. 4 for a trip through Italy, Switzerland, France and England, planning to return April 1 on the "Aquitania."

Robert Cramer has opened an office in Milwaukee, Wis., as consulting engineer and will specialize in the design and construction of power plants, refrigerating plants, heating plants and factories.

Rear Admiral R. S. Griffin, U. S. N. (retired), and Commander W. L. Cathcart, U. S. N. R., have associated, with offices at 149 Broadway, New York City. As the firm of Griffith & Cathcart they are prepared to undertake consulting work in marine and naval engineering, investigations, expert testimony, etc. Rear Admiral Griffin was formerly engineer-in-chief of the Navy.

Society Affairs

Coming Conventions

American Society of Heating and Ventilating Engineers—Annual meeting at New York City, Jan. 24-26. Secy., C. W. Obert, 29 West 39th St., New York City.

American Institute of Electrical Engineers—Midwinter convention at New York City, Feb. 15-17. Secy., F. L. Hutchinson, 29 West 39th St., New York City.

American Society of Mechanical Engineers — Spring meeting at Atlanta, Ga., May 8-11. Secy., Calvin W. Rice, 29 West 39th St., New York City.

Columbus Section, A.S.M.E., will hold a meeting Jan. 28, at which Arthur Richards will speak on "The National Engineering Societies."

Vancouver Section, A.I.E.E., is to hear an address on Feb. 3 by J. I. Newell on the "Development of the B. C. Electric Railway Co.'s Hydro-electric System."

New Britain Section, A.S.M.E., will meet Jan. 31 to hear Prof. L. P. Breckenridge, of Yale, speak on "The Importance of the Superpower System to New England."

Philadelphia Chapter, American Steel Treaters' Society, has arranged for an illustrated lecture on Jan. 27 by Howard J. Stagg, of the Halcomb Steel Co., entitled "Why Did It Break?"

Colorado Section, A.S.M.E., will meet at the Metropole Hotel in Denver, Jan. 27, for a talk on "Public Utility Problems," by Robert C. Newbury, of the Denver Gas and Electric Co.

The American Society for Testing Materials has set the date and place for its next annual meeting as June 26-July 1, at Atlantic City, N. J., with headquarters at the Chalfonte-Hedden Hall Hotel.

Philadelphia Section, A.I.S.E.E., will meet Feb. 4 for a paper by W. W. Pettibone, assistant chief engineer at

the Lebanon Plant of the Bethlehem Steel Co., entitled "Efficient Burning of Fuel and Use of Waste Gases in the Industrial Plant."

Bridgeport Section, A.S.M.E., has arranged a dinner and meeting for Jan. 26 at the Seaside Club. "Finance and Engineering" will be discussed by Edmund S. Wolff, president of the First National Bank. A motion picture, "From Hide to Leather," will be shown.

Boston Sections, A.S.M.E. and A.I. E.E., with the Massachusetts Chapter of the A.S.H. & V.E., will meet Jan. 24 for a dinner at 6 p. m., business session at 6:45 and professional meeting at 7:45. Discussion and action are expected on the proposal for an association of technical societies in Boston.

Providence Section, A.S.M.E., will hold its sixth annual banquet at 6:15, Jan. 31, with the affiliated societies at the Narragansett Hotel. Floyd W. Parsons, of *Gas Age-Record*, will speak on "Engineers in Public Service," and Daniel A. McKay, a captain in the Northwest Mounted Police, on "Public Service in the Northwest."

Business Items

The Reiter Boiler Cleaner Co., of Elgin, Ill., has recently incorporated, changing its name to the Reiter Company.

Reardon Bros. Co. has announced the opening of its contract department in the Manufacturers' National Bank Building, Lynn, Mass.

The CoKal Stoker Corporation, formerly at 1029 North Clark St., Chicago, will, on Feb. 1, move its general sales office, engineering and service departments to 341 to 349 East Ohio St., where it will have twice as much space.

The American Steam Gage and Valve Co., of Boston, Mass., has announced the appointment of G. A. Binz, formerly assistant sales manager to the position of sales manager.

The Cote Bros. Manufacturing Corp., maker of refillable fuses, has announced the removal of its general offices to the First National Bank Building, 38 South Dearborn St., Chicago.

The Harder Furnace and Engineering Corporation has announced that the Fuels Utilization Corporation, 152 West 42nd St., New York City, is handling the sale of its licenses to use the Harder patents, and of the services of its engineering department.

The Combustion Engineering Corporation has appointed W. C. Stripe, formerly engineer of the Philadelphia office, to take charge of the new branch office at Pittsburgh, and has transferred Otto de Lorenzi, test engineer, from the New York to the Chicago office.

The Chapman Valve Manufacturing Company, Indian Orchard, Mass., has announced the completion of its new electrically operated steel foundry, which will make it unnecessary to buy steel castings from outsiders. The building is 275 ft. long by 90 ft. wide. Practically all the equipment is electrically operated, including the melting furnace, which has a capacity of twelve tons in ten hours.

Trade Catalogs

Combustion—Uehling Instrument Co., 71 Broadway, New York City, Bulletins 220 and 221, "Magnitude of the Power Plant's Chimney Loss" and "Relation Between CO_2 and Money Wasted Up the Chimney." Short educational booklets explaining the need for CO_2 recorders.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run bases, f.o.b. mines):

Coal	Market Quoting	Jan. 9, 1922	Jan. 16, 1922
Pool 1,	New York	$3.15	$2.75@3.25
Pocahontas,	Columbus	2.15	2.00@2.30
Clearfield,	Boston	2.05	1.75@2.35
Somerset,	Boston	1.80	1.60@2.00
Pittsburgh,	Pittsburgh	2.15	2.10@2.20
Kanawha,	Columbus	1.75	1.65@1.95
Hocking,	Columbus	1.75	1.70@1.95
Pittsburgh No. 8	Cleveland	2.00	2.05@2.15
Franklin, Ill.,	Chicago	2.90	2.65@3.00
Central, Ill.,	Chicago	2.50	2.25@2.75
Ind. 4th Vein,	Chicago	2.25	2.40@2.75
Standard,	St. Louis	1.85	1.80@2.00
West Ky.,	Louisville	1.90	1.50@2.00
Big Seam,	Birmingham	2.10	1.90@2.30
S. E. Ky.,	Louisville	1.65	1.50@1.60

New York—On Jan. 19, Port Arthur light oil 22@25 deg. Baumé 4½c. per gal. 30@35 deg., 5½c. per gal., f.o.b. Bayonne, N. J.

Chicago—Jan. 19, for 24@28 deg. Baumé, 80@85c. per bbl.; 32@36 deg., 2⅜@2⅝c. per gal. in tank cars f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh — On Jan. 10, f.o.b. refinery, Pennsylvania, 36@40 deg., 4½c. Oklahoma 24@30 deg., 85@90c. per bbl.; gas oil, 32@34 deg., 2½c. per gal.; 36@38 deg., 2⅝c., 38@40 deg., 3¼c. per gal.

St. Louis—Jan. 14, prices f.o.b. cars, tank lots; 24@26 deg. Baumé, 85c. per bbl.; 26@28 deg., 90c.; 28@30 deg., 90c.; 32@34 deg., 3c. per gal.

Philadelphia—On Jan. 16, 26@28 deg. Baumé, Oklahoma, 85@90c. per bbl.; 30@34 deg., Oklahoma (group 3) 2¼@2½c. per gal.; 16@20 deg., Seaboard, $1.15@$1.25 per bbl.

Cincinnati—Jan. 16, for 26@30 deg. Baumé, 3⅜c.; Diesel 32@34 deg., 4¼c. per gal.; distillate 38@42 deg., 5c. per gal.

Cleveland — Jan. 16, 26@30 deg. Baumé, 2¾c. per gal.

New Plant Construction

PROPOSED WORK

Cal., Los Angeles — The Westinghouse Mfg. Co., Van Nuys Bldg., is having plans prepared for a 6 story, 170 x 239 ft. warehouse including a steam heating system on 5th and San Pedro Sts. About $700,000. Noernberg & Johnson, Los Angeles Railway Bldg., Archts. Five traveling cranes will be installed.

Cal., Porterville—The Bd. Educ., C. O. Premo, Secy., will receive bids until Feb. 1 for a 2 story high school including a steam heating system. About $270,000. Coates & Traver, Rowell Bldg., Fresno, Archts.

Cal., Santa Barbara—The Encanto Hotel Co. is having plans prepared for a 3 story hotel including a steam heating system on the Rivera. About $300,000. M. Hunt, 1107 Hibernian Bldg., Los Angeles, Archt.

Cal., San Diego—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., will receive bids until Feb. 1 for a refrigerating and cold storage plant. Noted Oct. 25. Spec. 4543.

Ill., Beardstown—The Bd. Educ., J. Listman, Clk., plans to build a 4 story high school including a steam heating system. About $300,000. Architect not selected.

Ill., Beverly Hills (Chicago P. O.)—The Beverly Hills Lodge, c/o Jobson & Hubbard, Archts., 225 North Michigan Ave., plans to build a 3 story masonic temple including a steam heating system on 103rd and Wood Sts. About $250,000.

Ill., Chicago — P. Gerhardt, Archt., 64 West Randolph St., is receiving bids for a 10 story, 90 x 104 ft. office and store building including a steam heating system on Milwaukee and North Aves. About $500,000. Former bids rejected. Noted Sept. 20.

Ill., Chicago—The Illinois General Hospital, c/o E. Grossman, Archt., 127 North Dearborn St., plans to build a hospital including a steam heating system at 460 East 32nd St. About $2,500,000.

Ill., Chicago—L. G. Hallberg & Co., 116 South Michigan Ave., is receiving bids for a 3 story, 190 x 267 ft. apartment including a steam heating system on Lincoln St., for M. Schuster, c/o Architect. About $300,000.

Ill., Chicago — The National Insurance Co., 29 South LaSalle St., has had plans prepared for a 21 story, 214 x 327 ft. office building including a steam heating system on Michigan Ave. and Pearson and Chestnut Sts. About $7,000,000. Graham, Anderson, Probst & White, 80 East Jackson Blvd., Archts.

Ill., Chicago—A. Proskauer, Archt., 127 North Dearborn St., is receiving bids for an 8 story, 52 x 250 ft. hotel including a steam heating system on Surf St. near Sheridan Rd. About $1,000,000. Owner's name withheld.

Ill., Chicago—H. J. Schlacks, Archts. 721 North Michigan Blvd., is receiving bids for a 6 story, 95 x 219 ft. apartment hotel including a steam heating system on DeWitt Court. About $900,000. Owner's name withheld.

Ill., Chicago—Zimmerman, Saxe & Zimmerman, Archts., 64 East Van Buren St., is preparing plans for a 1 story, 175 x 200 ft. theatre including a steam heating system on Blackstone and 55th Sts. About $400,000. Owner's name withheld.

Ill., East St. Louis—Cohn & Schein, 327 Missouri Ave., is having plans prepared for a 2 story, 275 x 300 ft. apartment (Nelco) on Missouri Ave. About $475,000. Boyer, Baum & Co., 1307 Syndicate Bldg., St. Louis, Mo., Archts.

Ill., Kankakee — The Kankakee High School Dist., c/o E. Hoennicke, 1057 Washington Ave., plans to build a 3 story high school including a steam heating system. About $500,000. Architect not selected.

Ill., Oak Park—H. J. Kusel, 1516 South Wabash Ave., is having plans prepared for a 3 story, 200 x 141 ft. apartment including a steam heating system on Washington Blvd. About $300,000. T. R. Bishop, 35 South Dearborn St., Chicago, Archt.

Ind., Evansville—M. S. Sonntag, H. E. Drier, Hogue Rd. and H. E. Bacon, 531 Main St., plans to build a 10 story, 67 x 144 ft. office and department store building including a steam heating system on 6th and Main Sts. About $400,000. Clifford Shopbell & Co., Furniture Bldg., Archts.

Ind., Fort Wayne—The Bd. Educ. is having revised plans prepared for a 3 story, 230 x 450 ft. high school. About $700,000. Griffith & Goodrich, 211 East Berry St., Archts.

Ind., South Bend—The Oliver Hotel Co., Main and Washington Sts., is having revised plans prepared for a 7 story, 65 x 125 ft. hotel. About $600,000. H. H. Green, 30 North Michigan Ave., Chicago, Ill., Archt.

Ia., Storm Lake—The city will receive bids for waterworks improvements: Sec. 1—250,000 gal. steel tank on 100 ft. tower; Sec. 2—pumping machinery; Sec. 3—pump house. Noted Jan. 10.

Kan., Hamilton—The city voted bonds for 75 kva. single phase electric light system including an outside substation. F. E. Devlin, Eldorado, Engr.

Ky., Louisville—The Belknap Hardware & Mfg. Co., 2nd and Washington Sts., will receive bids until Jan. 30 for a 13 story, 200 x 200 ft. warehouse. About $1,500,000. Graham, Anderson, Probst & White, Railway Exchange Bldg., Chicago, Ill., Archts.

Kan., Neodasha — The city will soon award the contract for one 250 hp. watertube boiler, surface condenser and auxiliaries, one 300 kw. steam driven engine or turbine, two 350 kw. full Diesel type oil engine. Black & Vetch, Mutual Bldg., Kansas City, Mo., Engrs.

La., Abbeville — The Vermillion Parish School Bd., W. Bernard, Pres., will receive bids until Feb. 17 for the construction of a low pressure steam heating plant for the Indian Bayou School, Indian Bayou. G. C. Honold, Archt.

Me., Portland—The Cumberland County Power & Light Co. plans to build an auxiliary steam power plant at South Portland. Initial capacity, 14,000 hp. About $500,000. Architect not announced.

Md., Easton—The Easton Utilities Comn. plans to install new turbine, engine and auxiliary electrical equipment at municipal power plant.

Mich., Detroit—J. S. Whitcomb Constr. Co., 525 Woodward Ave., is in the market for centrifugal pumps, 6 and 8 in.

Mich., Pontiac — The Masonic Temple Assn., is having plans prepared for a 6 story, 84 x 150 ft. masonic temple including a steam heating system. About $350,000. Verner, Wilhelm & Molby, 520 Book Bldg., Detroit, Archts.

Minn., Duluth—J. H. Davidson, 723 Plymouth Bldg., Minneapolis, plans to build a 6 story apartment hotel including a steam heating system, here. About $600,000. Private plans.

Minn., International Falls — The Bd. Educ., F. E. Patterson, Clk., is having plans prepared for a 2 story, 100 x 125 ft. high school including a steam heating system. About $250,000. Tyrie & Chapman, 1200 2nd Ave., South Minneapolis, Archts.

Minn., Minneapolis—The city plans addition to filtration plant, new pumping station, etc. About $2,000,000. W. N. Elsberg, City Engr.

Mo., Florissant—St. Stanislaus Seminary is having plans prepared for a 2½ story, 94 x 162 ft. chapel including a steam heating system. About $300,000. Wessbecker & Hillebrand, Pontiac Bldg., St. Louis, Archts.

Mo., St. Louis — The Missouri Athletic Assn., c/o W. Boering, Pres., 407 Washington Ave., is having plans prepared for a 6 story service building and power plant on 4th and Washington Aves. About $150,000. G. F. A. Brueggeman, Liberty Central Bank Bldg., Archt.

N. Y., Dunkirk—The Bd. Water Comrs. plans to construct an electric light and filtration plant. About $750,000. Engineer not selected.

N. J., Elizabeth—The Catholic Sisterhood, c/o R. L. Pryor, Archts. and Engrs., 859 Broad St., Newark, is having plans prepared for a convent here. About $400,000.

N. J., Elizabeth—Crow, Lewis & Wick, Archts., 200 5th Ave., New York City, will receive bids until Feb. 8 for a hospital building here for the Elizabeth General Hospital. About $600,000.

N. Y., Lyons—The Bd. Educ. will receive bids until Feb. 1 for a 2 and 3 story school including a steam heating system on Williams St. About $300,000. C. C. Ade, 344 East Ave., Rochester, Archt.

N. Y., New York—A Campagne, c/o R. Candela, Archt., 200 West 72nd St., is having plans prepared for a 15 story apartment on Bway. and 92nd St. About $1,500,000.

N. Y., New York—The 141 West 71st St. Corp., c/o Schwartz & Gross, Archts., 347 5th Ave., will soon receive bids for a 9 story apartment at 139 West 71st St. About $650,000.

O., Cleveland—The Union Terminal Co., c/o O. P. and N. J. Van Swearingen, Marshall Bldg. is having plans prepared for 10 story passenger and freight terminals consisting of 6 units on streets bounded by Prospect Ave., Ontario St., Columbus and Panal Rds. About $50,000,000. W. Pease, 613 Marion Bldg., Engr. Graham, Anderson, Probst & White, 80 Jackson Blvd., Chicago, Archts.

O., Dayton—The Dayton City Club, c/o F. S. Patterson, Chn. Bldg. Committee, Far Hills and Harmon Sts., plans to build a 3 or 4 story athletic club. About $500,000. Architect not selected.

Okla., Tulsa — A. C. Mayo, 5th and Boulder, plans to build a 20 story, 140 x 150 ft. hotel on 5th and Cheyenne Sts. About $2,000,000. Architect not selected.

Ore., Portland—The Bd. of Comrs., Port of Portland, 916 Spalding Bldg., will receive bids until Feb. 1 for furnishing 3 transformers with switches from 11,000 to 2,300 volts and 1,000 in.ft. electric dredge cable. About $8,000. J. H. Polhemus, 916 Spalding Bldg., Engr.

Ore., Portland—The Souereagn Hotel Co., 206 Concord Bldg., will open bids about Feb. 1 for a 7 story, 66 x 100 ft. apartment hotel including a steam heating system on Bway. and Washington Sts. About $300,000. C. L. Linde, Artisans Bldg., Archt.

Pa., Harrisburg—The Bd. of Directors for Poor for Dauphin County, H. W. Gough, Room 13, Court House, plans to install a generator at the county home to furnish electrical current to county institutions. C. M. Hersey, Court House, Engr.

Wis., Brillion—The village, E. Greuett, Clk., will receive bids until Feb. 7 for new sewer system including pumping and sewage disposal station. About $50,000. J. Donohue Co., 628 8th St., Sheboygan, Engr.

Wis., Madison—The city plans installation of heavy duty compressors and additional pumping equipment at waterworks system also construction of additional wells. E. E. Parker, City Hall, Engr.

Wis., Milwaukee — The Amer. Hide & Leather Co., 1320 Elston St., Chicago, Ill., is having revised plans prepared and will receive bids about Feb. 3 for a 3 story, 260 x 315 ft. tannery at 658 Commerce St. About $500,000. Noted Dec. 20.

Wis., Sheboygan—The H. C. Prange Co., 8th and Wisconsin Ave., is having plans prepared for a 3 or 4 story, 60 x 110 ft. power house and heating plant on 8th St. About $150,000. W. C. Weeks, 720 Ontario Ave., Archt. 350 hp. boilers will be installed. Noted Jan. 10.

Wis., Spencer—The Spencer Condensory Co., c/o E. Buss, Marion, Wis., is having plans prepared for a 2 story, 50 x 94 ft. condensory here. About $40,000. Private plans. Special machinery including power boiler, engine, belting and shafting will be installed.

Ont., Courtright — The council, A. C. Quick plans electric light and power distribution system. About $35,000. J. N. Wilson, 190 University Ave., Toronto, Engr.

Ont., Woodstock—The Electrical Comn. plans to increase capacity of plant, install additional transformers and extend transmission lines. About $28,000. K. W. Harvey, Chn., J. G. Archibald, Engr.

Tenn., Nashville—The Baxter Marble & Limestone Co., 638 Stallman Bldg., Address A. J. Baxter, Ch. Engr., is in the market for equipment including motor to operate 150 ton capacity crusher and 5,000 ft. transmission line.

Tenn., Nashville — The Rock Asphalt Bldg. Block Co., 638 Stahlman Bldg., A. J. Bright, Ch. Engr., is in the market for equipment including one 75 hp. electric motor.

Va., Norfolk—The city is having plans prepared for a 3 story, 100 x 300 ft. city market including heating, refrigerator and incinerator, etc., on block bounded by Market, Blewer, Tazewell Sts., and Monticello Ave. About $350,000. B. F. Mitchell, Seaboard Bank Bldg., Archt.

Va., Richmond—The city has approved an ordinance to appropriate $1,500,000 for water purification, pumping and distributing system.

Wis., Sheboygan—The Wisconsin Hotel Co., A. N. Merritt, Pres., Hotel Foeste, will receive bids until Jan. 31 for a 4 story, 75 x 139 ft. hotel including extension to steam heating system on 8th St. About $170,000. E. A. Stubenranch, 629 North 8th St. Archt. Two 10 hp. ice machines will be installed.

CONTRACT AWARDED

Cal., Lancaster — The Antelope Valley High School Dist. has awarded the contract for two 2 story additions to high school to Wopschall Bros., 360 South Raymond St., Pasadena, $183,001.40. A steam heating system will be installed.

Cal., Los Angeles—The Bank of Italy 7th and Bway., has awarded the contract for a 12 story, 113 x 115 ft. bank and office building on 7th and Olive Sts. to Lange & Bergstrom, Washington Bldg. Cost plus percentage basis. A steam heating system will be installed.

Cal., Oakland—The Sanitary Ice & Cold Storage Co., 26th and Chestnut St., has awarded the contract for a 1 story ice plant on 26th St., east of Chestnut St. to Nelson & Forsyth, Easton Bldg., $11,500.

Cal., Terre Bella—The Terre Bella Irrigation Dist. has awarded the contract for furnishing one horizontal centrifugal pump, capacity 5,000 gal. per min. against a head of 125 ft. direct connected to motor, also one electric motor 200hp. 2,200 volt, 3 phase, to Allis-Chalmers Mfg. Co., Rialto Bldg., San Francisco, $1,337. Noted Oct. 27.

Ill., Henry—The Henry Artificial Ice Co., C. N. Lucas, Pres., will build a 1 story ice plant. About $30,000. Owner will build by day labor. Noted Dec. 27.

Ind., South Bend — The LaSalle Hotel Realty Co., 415 Union Trust Bldg., has awarded the contract for an 8 story, 66 x 165 ft. hotel and stores building to the Bedford Stone & Construction Co., 810 Fletcher Savings & Trust Bldg., Indianapolis. About $850,000.

Ind., Terre Haute—The Union Hospital, North 7th St., has awarded the contract for a 6 story, 121 x 140 ft. hospital on North 7th St., to North Raffian Constr. Co., 914 Chestnut St.

Kan., Marion—The city has awarded the contract for waterworks system to include dam, filteration equipment pumps, motors, etc. to Burt & Tripp, Hutchinson, $54,997.34.

Md., Baltimore — The Church Home & Infirmary, Bway., has awarded the contract for a 6 sory, 86 x 125 ft. service building for hospital on Bway. and Fairmount Ave. to Frainie Bros., 18 Clay St., $271,000. Noted Dec. 6.

Mich., Detroit—The Columbia Realty Co., c/o Merritt, Harrison & L. A. Turnock, Archts., 500 Board of Trade Bldg., Indianapolis, Ind., has awarded the contract for a 15 story, 93 x 160 ft. office building. About $1,650,000. Contract has been awarded to architects. A steam heating system will be installed. Noted Jan. 10.

Mich., Detroit—The Detroit Yacht Club, A. A. Schantz, Chn. Bldg. Committee, Belle Isle, has awarded the contract for a 3 story, 80 x 325 ft. club house on Belle Isle to A. A. Albrecht Co., 1130 Penobscot Bldg. About $500,000. Steam heating boilers and equipment will be installed. Noted Aug. 30.

Minn., Minneapolis—The Bd. Educ., G. F. Womrath, Supt., has awarded the contract for a 3 story, 218 x 230 ft. junior high school on Clinton Ave. and 38th St. to Madsen & Peterson, 646 Builders Exchange Bldg., $309,658. A steam heating system will be installed. Noted Nov. 29.

Neb., Lincoln — The Bd. Educ. has awarded the contract for a 3 story, 169 x 261 ft. junior high school on 23rd and Vine Sts. to Olson Constr. Co., 202 Chapin Blk. About $499,000. Noted Dec. 13.

Neb., Lincoln—The city has awarded the contract for a furnishing and erecting on foundations furnished by the city, one 2,000 kw. turbo generator with 7,600 ft. surface condenser and switchboard complete to Allis Chalmers, West Allis St., Milwaukee, Wis., $70,460. Noted Dec. 20.

N. Y., New York — The Stuyvesant Estates, Inc., c/o Gronenberg & Leuchtag, Archts., 303 5th Ave., will build a 6 story apartment on Amsterdam Ave. and 92nd St. About $600,000. Owner will build by day labor.

Ore., Portland—The B. P. O. E., Bway. and Stark St., has awarded the contract for a 5 story, 100 x 150 ft. lodge on 11th St. between Alder and Harrison Sts., to Dougan & Chrisman, Railway Exchange Bldg., $949,500. Contract for heating will be awarded later.

Tex., Denison—The Missouri, Kansas & Texas R.R., Railway Bldg., St. Louis, Mo., has awarded the contract for a freight terminal consisting switching yards, round house, warehouse, shops, and other buildings, here, to the C. R. Cummings Co., Leader-News Bldg., Cleveland, O. About $3,000,000. Noted Jan. 10.